THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 42. Thursday, January 2, 1930. No. 698.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (4 lines).

Contents.

	PAGE
Forthcoming Events	1
Nineteen Thirty	1
Correspondence	2
Institute of Metals—Sectional Chairman	2
General Refractories, Limited, Sheffield	2
Random Shots	2
The Behaviour of Dissolved Gases in Cast Iron	3
Market Research in the American Malleable Industry	3
Coal Dust and Facings in the Foundry	4
Imported Bolts, Nuts and Rivets	6
British and Foreign Practice Compared	7
Nickel in the Iron Foundry	8
Taking Samples from a Blast Furnace	12
Book Review	12
Silica Refractories	13
Cleaning of Castings	13
Comparative Researches of Heat-Treatment of Case-Hardened Steels	13
A Shortened Malleabilising Process	14
Nickel-Chromium Steels in Trackwork	14
Pattern Plate Cost Reduction	14
American Foundrymen's Association Plans for 1930 Convention and Exhibition	16
A Short Paper Competition	16
Trade Talk	18
Personal	18
Obituary	18
Company Meeting	18
Reports and Dividends	18
New Year's Honours List	18
Iron and Steel Markets	20
Students' Corner	20

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT: 1929-30:
Wesley Lambert,
J. Stone & Company, Limited, Deptford, London, S.E.14.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.

Birmingham: F. K. Neath, 24, St. Paul's Square, Birmingham.

Sheffield: T. E. Walker, 26, Castlewood Road, Fulwood, Sheffield.

Scottish: J. Bell, 60, St. Enoch Square, Glasgow.

Lancashire: H. Stead, 1st/36, Cheetham Hill Road, Stalybridge, Cheshire.

London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.

Newcastle-upon-Tyne: F. Sanderson, 15, Handyside Arcade, Newcastle-upon-Tyne.

East Midlands: H. Bunting, 82, Otter Street, Derby.

West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.

Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitchurch, Glam.

Middlesbrough: F. A. Harper, "The Briars," Bishopton Road, Stockton-on-Tees.

Foundry Trades Equipment and Supplies Association.

President: H. Winterton,
Kelvinvale Mills, Maryhill, Glasgow.

Secretary: K. W. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Welsh Engineers' and Founders' Association.

Secretary, E. J. Griffiths, 20, Fisher Street, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION.

The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
Telephone: Central 1883. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332)*

Forthcoming Events.

JANUARY 3.

Institution of Mechanical Engineers:—Thomas Lowe Gray Lecture in London on "Progress in Marine Engineering," by Eng. Vice-Admiral R. W. Skelton, C.B., C.B.E., D.S.O.

JANUARY 14.

Sheffield Metallurgical Association:—General meeting at Sheffield, and Presidential Address

Institute of British Foundrymen.

JANUARY 3.

London Branch (Junior Section):—Ordinary meeting at 49, Wellington Street, Strand, London. "Some Foundry Facts and Fancies," Paper by C. Cleaver.

JANUARY 8.

Birmingham, Coventry and West Midlands Branch:—Visit to English Electric Company, Limited, Rugby.

Nineteen Thirty.

With the advent of the New Year it has been our custom for several years to outline the prospects for foundry industry. In doing this we make no attempt to emulate "Old Moore," but rather to indicate some of the factors from which foundry executives can draw their own conclusions. The two main factors, to our mind, are proposed legislative measures and rationalisation. The former throws a burden on industry, whilst the latter tries to neutralise its repercussion by more economical methods of manufacturing and marketing. On the result of this struggle will depend the final trading result. The recent activity in the foundry industry was a curious combination of two factors. Primarily, in certain trades it was associated with definitely new business, but in other sections, such as the foundries catering for mining and metallurgy, it represented accumulated work for replacements which in the normal course of events would have been placed in 1927 and 1928 as a steady stream. This has been due to the conservation of liquid cash resources due to bad trade. We feel sure that there is still a fairly large volume of work yet to be done in this direction.

A factor of first-class importance is the probability of increased cost of the foundries' raw materials. This always occasions a good deal of grumbling, but, taking the course of last year as a basis, trade was better as the price of pig-iron and coke rose. Buyers are inclined to hold off the market in times of falling prices, whilst the reverse is the truth when the opposite conditions prevail. This, of course, applies mainly to the home trade, but, again, we insist that if foundries are working to somewhere approaching capacity, it is surprising at how low an average cost production can be maintained.

Now that the Melchett-Turner conversations are of an official character, there is ground for hope that material good may be forthcoming. It certainly needs the best brains in the country to metamorphose many traditions to align them with modern conceptions of industrial effort. We suggest to the participants that every effort should be made to eliminate, on the one side, any impediment to the making of high wages, and, on the other, the amassing of high profits—a bankrupt industry cannot support high wages or, indeed, any at all.

The foundry equipment and supply industry can look forward to a good time, as the spirit of mechanisation is gradually permeating the whole industry. Naturally, this will entail a certain amount of economy in raw material, consequent upon more enlightened usage, but there will be the countervailing influence of increased production.

Dealing with the sections of the industry seriatim, we visualise for the shipbuilding industry a busy time on repair work consequent upon the recent gales, but for new tonnage we do not anticipate the figures reached last year will be maintained.

The automobile industry, providing it continues to enjoy the benefit of the Safeguarding of Industries Order, should improve upon last year's production, as there is an increasing export business to be expected.

Railway foundries are expected to be a little busier, whilst we anticipate something of a boom in agricultural implements. The recent rains in Australia will undoubtedly be reflected in the export business. They have a good deal of leeway to make up.

The pipe founders of Great Britain have to thank the Argentine for the improvement shown last year. If that business can be maintained and the Australian turnover brought back to normal, a good increase in the export business should be shown.

Finally, we come to the light castings industry. This section registered some improvement last year. A hard winter would help to counteract the easing off of building operations. We hope that last year's abortive effort to reorganise their employer's federation will not prejudice further effort as so much useful work could be accomplished. The industry is subjected to intense foreign competition, and needs all the help that legislation, co-operation, rationalisation and research can give it.

From the steel foundry industry we expect a distinct improvement, as the liquidations of the last eight or nine years have largely weeded out many of the smaller and less efficient establishments, and it can truthfully be said that with a few exceptions it is in a very healthy condition. It is well prepared to take care of any increased business that may be offered. The non-ferrous foundry trades represent so many sections of other industries that it can only be said to follow the general trade conditions of the whole country.

On the technical side of the industry, the annual convention of the Institute of British Foundrymen is to be held at Middlesbrough, under the chairmanship of Mr. J. P. Wilson, steel foundry practice is to be made a feature of this conference. A Pan European Foundry Congress is to be staged in Belgium, and it is a *sine qua non* that a large number of British foundrymen will take part.

Finally, we take pleasure in wishing every member of the British foundry industry a happy and prosperous New Year.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Iron and Steel Institute.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—This is the season for the making of New Year's Resolutions, and I venture to make the following suggestion to the readers of your valuable publication. For my purpose I divide your readers into two categories: (*a*) Members of the Iron and Steel Institute, and (*b*) Non-members. To the former I say, "Resolved: that I will obtain at least one new member for the Iron and Steel Institute during the coming year." To the latter I say, "Resolved: that I will take up membership of the Institute with the utmost despatch."

That the Institute has laboured long and arduously for the benefit of both the iron and steel manufacturers *and* the users is beyond dispute; nevertheless, individuals cannot be expected to become members simply from a sense of altruism. What, then, are the benefits to be derived from membership? The Institute is bound by its constitution to hold at least two principal meetings in the year; in addition, the Council may authorise further meetings to be arranged. Last year, besides the general meetings in London and Newcastle, four additional meetings were held in Glasgow, Sheffield, Scunthorpe and Birmingham, respectively. The reading and discussion of papers at these meetings is, of course, an important part of the proceedings, but there is another equally important, though more personal and less formal, aspect of these functions; members have an opportunity to "get together" and discuss their own troubles and difficulties. Therein lies a special interest for the steel users, and the Council are especially anxious that the number of users, particularly those engaged in the further treatment of steel, on the roll of the Institute should be considerably increased; if the British engineering and iron and steel industries are to advance and compete successfully with their competitors under present-day conditions, they must throw their various experiences and knowledge into the common pool—the Iron and Steel Institute affords the means for this.

Another asset of membership is the Library of the Institute. It may be fairly claimed without exaggeration that the Library is the finest specialised collection of literature on iron and steel technology and allied subjects in the Kingdom. Members may consult text books, volumes and periodicals in the reading room, or may borrow them on the simplest of conditions imaginable. Members are notified at intervals, on request, of all recent additions to the Library. A "Library Service" has been in operation for some years now, and the number of requests for information and for references to the literature on the most varied subjects is steadily increasing.

It only remains for the resources of the Institute to be augmented for it to become of even greater assistance to the industries which it serves than it has been in the past.—Yours, etc.,

G. C. LLOYD, Secretary.

January 1, 1930.

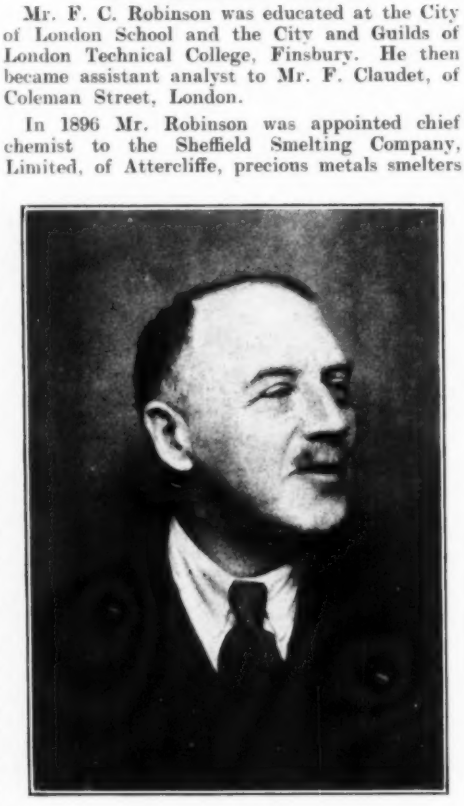
ACCORDING to the latest advices from Germany, it is becoming increasingly common to transport powdered fuel in specially designed wagons to the steelworks and foundries for immediate use. This system undoubtedly supplies the application of powder coal as a fuel for the smaller establishments.

Institute of Metals—Sectional Chairmen.

No. 3.—SHEFFIELD SECTION.

Mr. F. C. Robinson was educated at the City of London School and the City and Guilds of London Technical College, Finsbury. He then became assistant analyst to Mr. F. Claudet, of Coleman Street, London.

In 1896 Mr. Robinson was appointed chief chemist to the Sheffield Smelting Company, Limited, of Attercliffe, precious metals smelters



MR. F. C. ROBINSON.

and refiners. Later he became technical works manager, and still retains that position.

From 1914 to 1917 he was engaged upon war service, and was assistant analyst to the Admiralty Inspection Office and to the Ministry of Munitions, Sheffield, from 1917 to the Armistice.

Mr. Robinson is also an associate member of the Institution of Mining and Metallurgy.

General Refractories, Limited, Sheffield.

A banquet was given at the Royal Victoria Hotel, Sheffield, on December 19, 1929, by General Refractories, Limited, of Sheffield, to their salesmen and staff to commemorate the record sales of October, 1929, which exceeded any previous total in the history of the company. Mr. Frank Russell, chairman and managing director, presided.

Mr. R. W. Matthews gave "The Sales Organisation," and commended the spirit of hard work which had been evident, whilst the service the firm gave to its customers had also played no small part in the achievement.

There was also a presentation of prizes to those representatives who had shown the largest increased percentage of sales. Mr. A. Whiteley, on behalf of those present, presented to Mr. Frank Russell a pen-set as a memento of the occasion. Mr. Whiteley said that it was due to Mr. Russell's energy and foresight that they had met that night. He hoped Mr. Russell would accept that little token of their very deep regard for him. Mr. Russell suitably responded.

Random Shots.

I suppose few recent movements towards industrial peace, so-called, have aroused more interest and greater expectations than the one that began two years or so ago on the initiative of Lord Melchett—only he wasn't Lord Melchett at the time, was he? Yet subsequently, I daresay, some of us were disappointed, and were inclined to feel that very little had come of it all but talk. Such disappointment was evidently premature, for now comes the news that the discussions are to be resumed, and this time on an official basis. This means that both sides concerned are prepared to create the necessary machinery for giving effect to the recommendations resulting from the discussions, and of course it alters the whole character of the thing. Its weakness lay before in the fact that, having no official standing, it was open to every attack of those who disapproved. People may grumble at officials and institutions, more from force of habit than anything else—but such grumbles lack the potency and the virulence of attacks on the unofficial and adventurous!

* * *

A most interesting list is given of the subjects that will be discussed under these distinguished auspices in the near future. They are as follow:—Unemployment, industry and finance, the taxation of industry, co-ordination of the social services, education and industry, inter-Empire trade, with special reference to the Imperial Conference and to the Imperial Economic Conference, international trade, insurance of export credits, trade facilities, international labour questions, and commercial statistics. So far, so good. But I don't see anything about industrial research, and that seems a pity. I hold no brief for any particular shape or form of industrial research, but it seems to me that very few intelligent men in industry to-day would deny its importance, even if they are not able actively to prosecute it themselves. Not so the Trade Unionists as a whole. The fault lies, I suppose, with our educational system, based as it is, even in the elementary schools, on a classical and not a modern tradition. There are plenty of men from the public schools and the Universities who profess a fine superiority to science and all its works, and while that is the case it is hardly fair to blame the working man for the same thing, especially since a good deal of scientific material is presented in a fashion peculiarly abstruse.

* * *

The spate of war stories in the daily and evening Press has been an interesting phenomenon. It is a kind of popular counterpart of the huge demand for war books in the libraries, and of the success of the war plays—or some of them. Personally, I have encountered little in these war anecdotes that really made me laugh, although I must admit that where humour is concerned I am something of a captious critic. In many cases, too, an appreciation of the humour appeared to depend on personal acquaintance with the particular set of war conditions described, and, since no one could be everywhere at once, only a minority of the stories would appeal to any one reader. I encountered one whose humour was general rather than particular. It concerned the prisoner of war whose Christmas parcel contained a bottle of "lung syrup." The officer in charge demanded to know if he was really ill, and, on being assured of the fact, handed over the "lung syrup," which had been made in Scotland, and which was taken several times daily with a good deal more relish than most medicines.

MARKSMAN.

The Behaviour of Dissolved Gases in Cast Iron.*

By J. E. Hurst.

One of the most important features of cast iron at the present time was the question of soundness. In spite of all the excellent experimental work which has been carried on during the last ten years, the higher tensile strength and the wonderful quality which can be produced, the engineer was still very much loth to raise the stress limit in designing structures. No engineer would be bold enough to exceed the safe working stress of 4 tons per sq. in. in small castings and 1½ tons per sq. in. for larger castings. The one thing about which the engineer needs to be sure was that the casting as a whole is sound.

Therefore the scientist claimed attention in all these interests in the development of cast iron. A contributory cause of unsoundness in cast iron is dissolved gases, but most certainly dissolved gases are not the sole cause of unsoundness. The speaker absolved the moulder of much of the blame for unsound castings, and to-day it was more and more appreciated that it was more a question of the metal than of the mould. It was well known that most metals dissolve gases, and some to a larger extent than others.

Referring to experiments made by pioneer scientists, Mr. Hurst said that these early metallurgists, in searching for soundness, resorted to a variety of methods, and these could be classified under two headings. First, mechanical; secondly, metallurgical methods. Under the first heading there were the methods of agitating, and casting under pressure, and they were both designed with the object of removing dissolved gases and providing sound castings. Under the second heading they had the methods which depended on the addition of elements such as aluminium and manganese; on the control of casting temperature and the control of the rate of pouring, all of which had as their objects the alleviation of defects caused by dissolved gases. Some of the early mechanical methods provided an interesting study, particularly in the light of modern developments. Probably the most illuminating examples could be found in a study of Sir Henry Bessemer's work. Bessemer was responsible for a large number of patents in addition to the one for which he was most famous—the production of steel by the pneumatic process. In his patent of 1856 he proposed that the ingot mould should be constructed on an airtight principle, and the result of the process was that the ingots showed less tendency to become porous. In another patent the process was reversed and air was forced under pressure into moulds which were sand-lined to allow for slow cooling and ultimately to provide for the disengagement of the gases. This was followed by a proposal to oscillate the molten metal. In 1857 Bessemer turned his attention to a form of the centrifugal method. In 1863 Bessemer, again still in trouble, devised a method of violently agitating the molten metal in the ladle with a rotating paddle. In his own words, he agitated the metal one hundred times per minute, and the whole operation only required two or three minutes. All metallurgists were, of course, aware that none of these methods was used ultimately, but reference to the work of early investigators showed the long appreciation of the presence of dissolved gases. As recently as in 1929 quite a number of thermal and electrical methods of agitating baths of molten metal were adopted with the object of freeing the metal from dissolved gases.

Dealing with the process of pre-solidification, the lecturer said that the effect of pre-solidification was to allow the dissolved gases to be liberated at the point of solidification. It was found in cupola experience that, on re-melting, the amount of gas re-absorbed was nothing like the quantity which was present in the metal in its original state. The process was amplified in one or two other patents by the introduction of mechanical methods in assisting in the disengagement of dissolved gases.

Dissolved Gases in Cast Iron.

Turning to the presence of dissolved gases especially in cast iron, Mr. Hurst said that the quantities varied from one-third to three or four times the volume of the cast iron itself. The composition of these dissolved gases was generally considered to be of hydrogen, nitrogen, carbon dioxide, carbon monoxide and methane. Hydrogen seemed to be the principal element, followed by nitrogen, carbon dioxide, carbon monoxide and lastly methane. Unfortunately, it was difficult to investigate the condition of the dissolved gases, and it became insuperable in alloys. The vital factor so far known was that the solubility of dissolved gases was much less when the metal was in the solid state than in the liquid state. Consequently, when the molten cast iron was cooled down from the liquid to the solid state the gas tended to be liberated when passing through the solidification period. In foundry processes it was by no means easy to trace unsoundness by direct methods, and they had to rely on inferential methods.

The influence of dissolved gases in causing defects was a real trouble. Fortunately, in ordinary sand castings the trouble from dissolved gases in cast iron was much less than in any other alloy known to the industry. The reason for this had never been satisfactorily explained, but it was probably due among other things, to the fact that at the same time that the dissolved gases were liberated there were other changes taking place in cast iron—for instance the formation of graphite—and that very much helped in rendering the effects of dissolved gases innocuous. If this formation of graphite did not take place, the liberation of the dissolved gases would be accentuated by the formation of defective blow holes, with the result that, instead of taking the form of holes, they took the form of what the metallurgist calls graphite voids. He had already indicated that the majority of dissolved gases were liberated at the point of solidification. There were at least two theories which had been put forward to account for this openness of grain in the centre of cast-iron castings, except of the smallest section.

Mr. Hurst, continuing, said that it had been proposed to return to the old mechanical methods for the prevention of unsoundness. One such method was that of jolting the molten metal and another method was that of jolting and agitating pig-iron under control of temperature, and these methods might be regarded as being complimentary to the old metallurgical methods.

He explained that he had been prompted to choose this subject for his lecture by a Paper given at the Foundrymen's Conference that in America it was considered that the influence of dissolved gases was of very little importance in castings. He felt bound to show that the importance of dissolved gases could not be neglected.

In the discussion which followed, one of the questions put to Mr. Hurst was what did he consider casting temperature? "My casting temperature is at the point of a stream of metal being poured into the mould," he said. Suitable casting temperature, he thought, depended on the character of the casting. On a small casting the temperature could not be too high; the higher the better. In the case of other castings he thought a medium casting temperature, such as laid down by Dr. Hatfield, was the best.

The Chairman had told them that if they could get even higher temperatures than those already in use they would get better results, and the Americans and Germans had had some very good results from superheating.

A vote of thanks was proposed by MR. HARRISON, seconded by the CHAIRMAN, and heartily endorsed.

* An abstract of a lecture given to the Middlesbrough Branch of the Institute of British Foundrymen, Mr. N. D. Ridsdale, F.I.C., presiding.

Market Research in the American Malleable Industry.

The scope of activities of the Malleable Iron Research Institute will be materially enlarged in order to broaden the field for malleable castings. Action on the extension of work of the organisation was taken at the annual meeting of the Institute held in Cleveland on December 11.

Laboratory and metallurgical work up to the present has dealt mainly with improving the quality of the product and the efficiency of plant operation. This phase of production research will be continued on an enlarged scale, supplemented by comprehensive plans for shop practice and product inspection services. In addition, a broad programme of market research will be undertaken which will include a comprehensive survey of the industry.

This will embrace thorough studies of new uses and applications, of specifications of materials for specific purposes and of the study of marketing conditions as affecting the use of malleables, all of which will be supported by a broad programme of co-operative advertising. One subject that will be considered will be the provision of different specifications for malleable castings providing specifications for castings for different services to supplement the present single standard specifications of the Institute. For the effective conduct of the enlarged activities the personnel of the Institute will be increased by an additional administrative executive and field engineers.

Mr. R. R. Fauntleroy, of the Moline Malleable Iron Company, St. Charles, Ill., who became president of the Institute early last year to fill the vacancy caused by the death of Frederick L. Sivyer, was elected president for the ensuing year. Other officers elected were: Vice-presidents, John G. Malnoski, Muncie Malleable Foundry Company, Muncie, Ind., and Joseph P. Kennedy, Baltimore Malleable Iron & Steel Castings Company, Baltimore; secretary-treasurer, Robert E. Belt, Union Trust Building, Cleveland.

Waste in Steel Foundries.

At a meeting of the Steel Founders' Society of America, held in Pittsburgh last month, a Paper on "Undeveloped Wealth in the Steel Foundry" was presented by George Batty, technical director of the Steel Casting Development Bureau, Philadelphia. He called attention to the fact that foundry superintendents acquire a large amount of data on foundry operation that they do not fully understand and, if they do, do not have the time, opportunity or training to deduce from their observations improved practices or remedies for adverse conditions noted. These empirical facts existing in the minds of foundry operators constitute unexploited wealth, he declared, for if they were collated scientifically new methods could be devised that would materially reduce wastes in both material and human energy.

XUM

Coal Dust and Facings in the Foundry.*

SOME PRACTICAL EXPERIMENTS.

By H. Winterton.

It is now some twenty years since the author gave his first Paper upon the question of facings, and, although many debates have followed, and many more Papers have been given, both by practical and technical experts, can it be said that the industry has progressed in a manner which has brought it to a complete understanding of the position, or even sufficiently far to declare that there are definite data upon which to work out its salvation so far as moulding problems are concerned? Unfortunately, this is not the case.

This Paper is an endeavour to record some results which are both interesting and instructive. So far as the illustrations are concerned, the castings, except one, were made with fine or superfine coal dust of approximately the following analysis:—Carbon, 56.8; volatile, 31.2; and ash, 12 per cent.

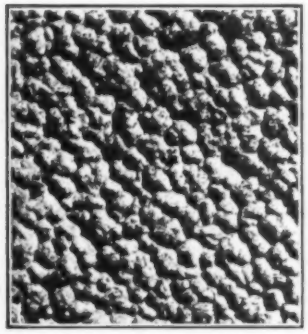


FIG. 1.—COAL DUST, 50 PER CENT.

FIG. 2.—COAL DUST, 43 PER CENT.

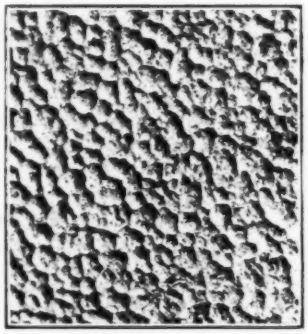


FIG. 3.—COAL DUST, 33 PER CENT.

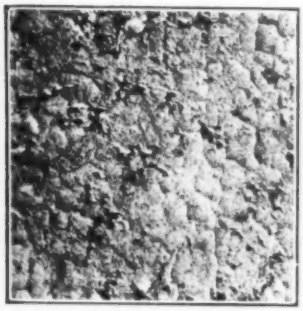


FIG. 5.—COAL DUST, 20 PER CENT.

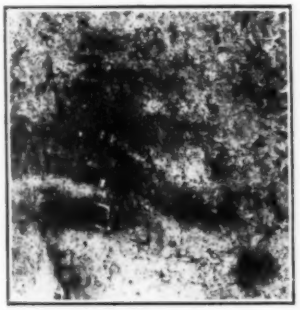


FIG. 6.—COAL DUST, 11 PER CENT.

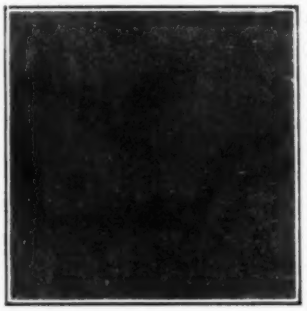


FIG. 7.—COAL DUST, 8 PER CENT.

Coal Dust.

The author is fully aware of the varying circumstances prevailing in different foundries, and that it is frequently impossible to carry out in one foundry the principles enunciated by another with the exactitude of a mathematical formula. In the first place, are all founders unanimously agreed as to the use of coal dust in the mould? The reply of one moulder to the query, "For what purpose is coal dust put into facing sand?" was, "Why, it is the stuff that makes the casting rough and dirty when you don't put it in." His method of expressing himself may have been somewhat involved, but undoubtedly truth was embodied in his remarks. The illustrations will certainly prove that the total absence of coal dust in the mould is just as bad as an excess of the article, although in widely divergent directions.

In the experiments ordinary red Wolverhampton sand was used, and it was sieved, dressed and prepared in the manner customary in a large percentage of foundries throughout the country. The black sand was ordinary floor sand, which, of course, contained a certain proportion of coal dust in various stages of decomposition. The castings were made from wooden patterns 8¼ in. by 8¼ in. by ½ in. Each of the moulds, so far as the specimen plate castings were concerned, was made in the same manner and not vented.

It is reasonable to conclude from the results that, when the gas is generated rapidly, there is a furious battle raging between the live metal and the volume of gas which forces its way along the face of the sand and metal and out at the joint, this being the line of least resistance. The very moment the mould was full, the gases came through the joint and fired instantly, there being no time for the gases to travel through the pores of the sand and out at the joint, so they must have come along the face of the metal. The distance from the casting to the edge of the moulding box was only 1¼ in., and this made a very easy channel for the escape of gas, although the top part of the box fitted closely to the bottom part and so sealed the joint. Thus, although there may be room for the gas to escape, it does not follow that the live metal can force its way through the same aperture. Moreover, while this gas evolved from the coal dust is passing between the live metal and the face sand of the mould, it is doing its work—that of providing a protective barrier by forming a film of carbon from the decomposed coal dust on the face of the sand of the mould. This surely leads to the assumption that the provision of good-class coal dust, of a proper grist and carefully graded, tends to produce a casting of far better appearance than when sufficient care is not exercised.

When coal dust is used in proper proportions, it most certainly makes a wonderful difference to the face of the casting, and in cases where it is not used, the casting presents a very harsh and grey appearance. On the other hand, it is essential to guard against the excessive use of coal dust. It may be argued that some of the troubles have been unnecessarily magnified, but this has only been done in order to show how very necessary it is to use the greatest care, and how gravely castings deteriorate when irregular proportions of sand and coal dust are used. Much of the disfigurement of castings, it will be seen, is directly attributable to an abuse of coal dust, or the use of coal dust and sand improperly mixed, but, when a moulder has provided proper proportions, excellent castings result, and the variation between individual productions is very slight.

This latest phase of experiment, bringing the author closely, as it has done, to the why and wherefore of foundry practice, has caused him to modify to a somewhat extensive degree his original belief that the coal dust assisted to a considerable extent to form a vent, through which the gases might escape. Though in a lesser degree this may be the case, the conclusion has been reached that the venting of a casting depends principally upon the moulder, and not to the extraneous assistance of the coal dust. This brings the question back to the conclusion that the molten metal, rushing through the mould, causes a film of gas to form which protects the sand, and which provides the

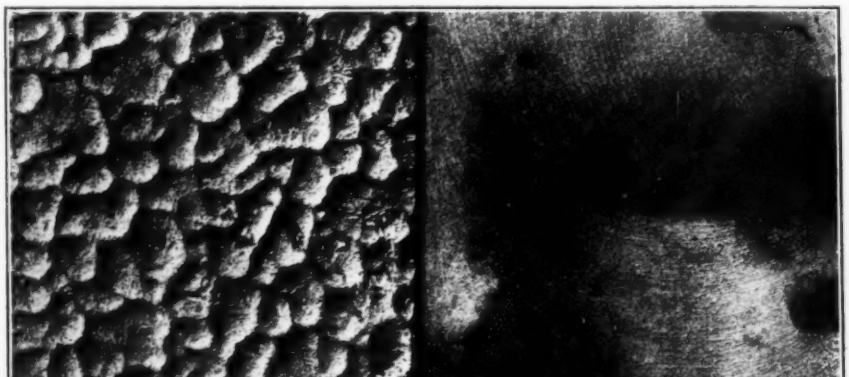


FIG. 4.—COAL DUST, 33 PER CENT., BEFORE AND AFTER SKIN MACHINING.

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen. Mr. G. Oxley, presiding.

attractive blue skin on the face of the casting. One important matter which the moulder has to consider is the grist of the coal dust he uses. After many tests the author has arrived at the definite conclusion that the heavier the casting the coarser may be the grist, because of the greater quantity of heat consequent upon the greater weight of metal. It naturally follows that the formation of gas will be more pronounced, but this is satisfactorily taken up, as

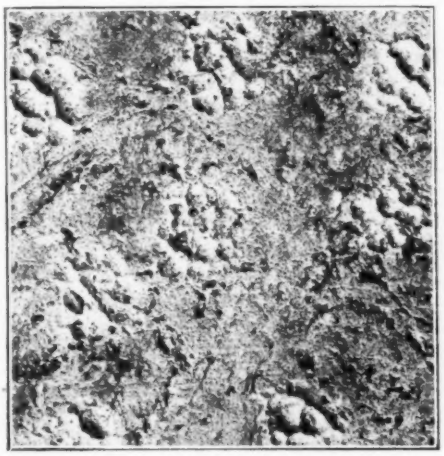


FIG. 8.—RESULT OF BADLY-MIXED FACING SAND.

it were, by the fact that there is a much heavier body of metal, and the pitting, which would otherwise take place, is, with the thicker casting, non-existent.

Metal poured into a mould made up of very coarse coal dust with sand can give castings which strip excellently and without the slightest sign of pitting. Much has been said recently about the proposition to eliminate entirely coal dust, and tentative experiments have been made

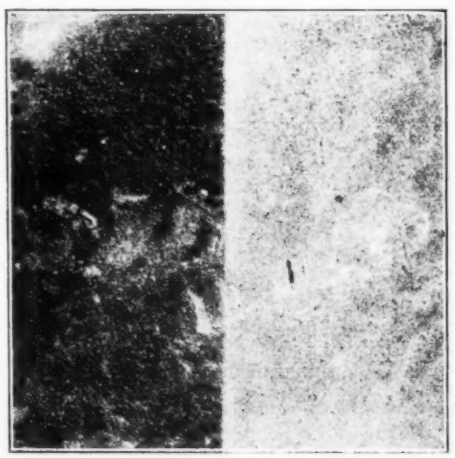


FIG. 10.—COAL DUST—NIL.

with this object in view. So far, however, the results have not justified the extension of the practice, and it will be a long time before foundrymen generally take the risk involved by such an idea. If it were possible to obtain an ideal sand whose refractory quality and permeability were of such a precise nature as to permit of exact standardisation, the provision of coal dust might not be necessary, but, failing this, some aids must be called in from the outside, and practical experience for many years has proved to the foundryman that the addition of coal dust is the most satisfactory so far as the finished article is concerned.

Many of the troubles in the foundry at present attributed to the refractory or facing arise from other sources, and this was impressed upon the author in the course of his recent experiments when he was able to obtain a photograph of a blow-hole actually in course of formation. During the process of pouring a curious phenomenon was witnessed through the mica window. The photographer was waiting for the signal to expose his plate, and at the moment the signal

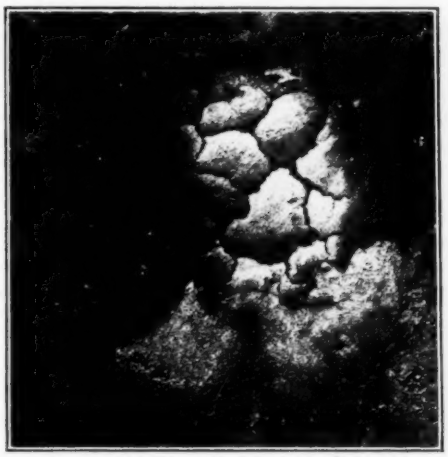


FIG. 9.—CONTRACTION CRACK IN SAND FACE.

was given a violent agitation was observed in the mould; steam rose from a damp spot, and dispersed at the moment the exposure was made. As shown by Fig. 14, the result is illustrated very clearly, and the actual blow-hole is to be observed in the resultant casting. All blow-holes are not, of course, caused by exceptionally damp spots in the moulds, but undoubtedly the photograph is the production of a very common blemish in castings.

The experiments forming the basis of this Paper were initiated by making a casting in a facing sand consisting of 25 per cent. red sand, 25 per cent. black sand and 50 per cent. coal dust. It was arranged to obtain a maximum bad casting, showing clearly an example of mapping, which is so pronounced that it cannot be called pitting, and, were the word not usually understood to mean something different, one would be inclined to call this a fine specimen of a honeycomb. A second casting was moulded in the same way as No. 1, but the coal dust was reduced to 43 per cent. Although there is little difference in the mapping, it is somewhat less pronounced and a little darker in colour. In a third test, the coal dust was further reduced to 33⅓ per cent., with the commensurate increase of the red and black sand in equal proportions. These results are shown in Figs. 1 to 3 respectively. This third casting was partly machined to demonstrate the effect this pronounced mapping had upon the casting. While the face of the casting is so badly veined, the interior of the casting has certainly not been affected (Fig. 4). A fourth sample contained 20 per cent. of coal dust in the facing sand, and it will be noted from Fig. 5 that the mapping is very much reduced, although the casting is somewhat dirty. The fifth example was moulded in a facing containing 11 per cent. of coal dust, and a better casting was obtained. The mapping is certainly observable, but the face of the casting is almost clean. The next test was carried through with a facing consisting of 25 per cent. red sand, 67 per cent. black sand and 8 per cent. coal dust, and the casting was practically perfect. It is shown in Fig. 7.

A piece of sand from the face of the mould No. 6 definitely showed contraction and not expansion, as is generally believed. This contraction of the sand may support the idea of many foundrymen that the coal dust assists the venting, as there was no mapping marks on the casting, and the temperature of the metal at pouring was the same as in all the other experiments. It was noted that the metal did not fill in these cracks, so it would seem reasonable to conclude that it must have occurred while the metal was solidifying. This provided channels for the gas to pass into the main body of the sand. Some may hold that the action of drying a green-sand mould would cause these cracks. Fig. 9 clearly shows that the contraction occurs only where the coal dust has been excessive, but not elsewhere. Fig. 8 shows the result of a badly-mixed facing sand. The casting was moulded in a facing sand of 4 parts red sand, 8 parts black sand and 1½ parts coal dust by measure. Small holes were cut out of the face of the mould, and into these holes a facing sand mixture with 50 per cent. coal-dust content was pressed and sleeked level, with the result that the casting was very dirty and mapped in those places.

Fig. 10 represents an attempt to make a casting without coal dust, and for this purpose floor sand was not used, as this contains coal dust in a certain proportion, however small. Red sand and fettler's sand were used in equal proportions, and the result was decidedly bad. The sand was firmly fixed to the casting, and a file had to be used to remove it. Even then the casting was very rough, and, if it were part of a casting that had to be machined, the fitters would certainly have had considerable trouble, to say nothing of the ruin of the cutting edge of the tool. The colour also is of a hard grey shade, and, generally speaking, the appearance of the casting left very much to be desired.

When a mould was poured with a facing containing 50 per cent. coal dust, the gas rushed out from the joints of the box, but when poured with a normal amount of coal dust, the difference between the two was most noticeable. Fig. 11 shows the general arrangement of the experimental mould with mica windows, whilst Fig. 12 is a close-up view of the mica window, showing the metal actually in the mould. To give a longer exposure, pouring was stopped when the metal was only halfway up the mica window. The straight line is the back of the metal; the curved line is the front, so that one is looking on the top of the metal. The smoke

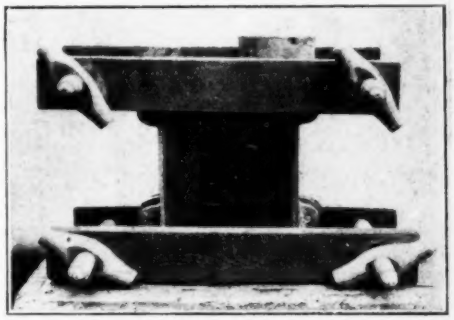


FIG. 11.—ARRANGEMENT OF TEST MOULD.

can just be noticed. Fig. 13 shows a mould with the casting removed. It illustrates the method of pouring from the bottom, and outlines the course of the molten metal in the mould. The curious result to which the author referred in his remarks previously, when a kind of explosion was observed, is shown in Fig. 14; the steam rose from the spot at the back of the mould, and the result was the curious blow-hole which is observable in the actual casting.

The author's remarks have now to be confined to coal dust, because, judging by the amount of correspondence which has been taking place for a number of years, and particularly since the

publication of Mr. Hird's excellent Paper on this subject, the interest of foundrymen has been stirred to an unprecedented extent.

In connection with the carboniferous facings which are necessary in the production of iron castings, although the blacking of moulds, either wet or dry, has the same object as the mixing

Fig. 12. — Metal Rising in the Mould.

of coal dust with the sand, namely, the production of a perfect casting, the handling of such a facing is a totally different proposition. It has been proved, not only by practical experiment, but by technical research, that the facing which will bring out to perfection the casting of one particular size and shape would be of little use

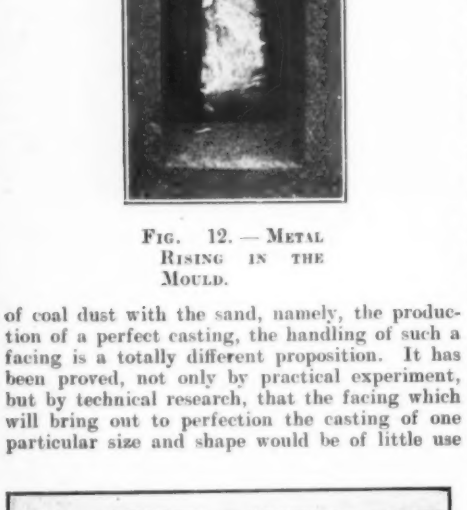


Fig. 13.—Internal Arrangement of Test Mould.

where possibly the thickness of the metal and other details made the successful casting a difficult proposition. The author has frequently experienced a facing which might have had excellent results under certain conditions, but has been proved to be positively harmful where another set of conditions was in vogue. Foundrymen are prone to condemn or commend the facing without being able to explain in what way it excelled or fell short. Collaboration between the foundryman and the facings manufacturer would be to the advantage of both parties, and it is upon this ground that the author adds a few remarks to the controversy as the qualities of certain classes of facings.

The base of iron-foundry refractories is carbon, and this is marketed in various forms. One of the best, though possibly the dearest, forms is plumbago, and, generally speaking, for green-sand work, no better facing exists. The function of the facing is to prevent the molten metal from eating its way into the mould, and at the same time to form a skin or face on the casting which will cause it to strip readily from the mould, and so reduce the cost of fettling to a minimum.

If the most important point to be considered were the question of carbon content, the situation would be very much simpler. The nature of the mould, the class of the casting, the condition of the various sands, and other details, have all to be borne in mind, and it is, therefore, impossible to produce any one facing which will satisfy the demands of every mould, whatever its character. It was formerly thought—and many moulders still hold the opinion—that no facing could equal the old charcoal blacking, either for green sand or cores, but with the preparation of modern blackings this idea has been metamorphosed, and moulders now require facings of varying constituents, carefully prepared and manipulated to give the best results for any class of mould. With varying conditions, therefore, it becomes necessary to make blackings of different strengths, textures and grists. For instance, the blacking which is in general use on boilers and similar hollow-ware moulds would cause disaster if applied to the mould of a casting intended to undergo porcelain enamelling. This was proved years ago, when porcelain enamelling was in its infancy, and considerable difficulty was experienced in getting the enamel to run evenly over the surface. Experiments proved that this was due to the action of one of the ingredients—and a very important one, too—in the blacking. It was only after much

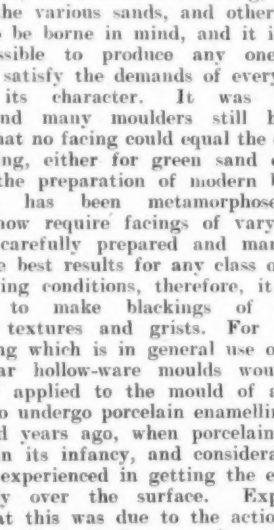


Fig. 14.—Formation of a Blow Hole.

research that the trouble was eliminated, and an efficient substitute found, and the author thinks that a facing has now been evolved which will prove highly effective and incapable of improvement for a very long period. The carbon content of this blacking is not nearly so high as some of the lower-priced grades, but it is efficient for its particular job. This point bears out the fact that, although a high percentage of carbon is necessary if some castings are to strip cleanly, there are other moulds which require treatment with a mixture of various ingredients, each of which shall in its own particular way assist the moulder in his efforts towards securing a mould affected by the heat to the least possible extent, and thus ensure a casting which shall reduce the fettling costs.

The secret of successful facings is the blending of certain refractories in such a way as to meet the variable requirements of the different foundries, castings and temperaments to be met with amongst the workers—not an easy task, but one which, in the light of present-day research, is not altogether unattainable. Of late years considerable strides have been made in the direction of progress in this subject, and, if the outcome of meetings tends to shed more light on this little-known subject, it will be for the benefit of the industry and its workers.

Imported Bolts, Nuts and Rivets.

Application for Marking Order.

An application has been made to the Standing Committee of the Board of Trade, under the Merchandise Marks Act, 1926, for a marking Order for imported bolts, nuts, rivets, etc., of iron and steel. The applicants are the Bright Bolt and Nut Manufacturers' Association and the Black Bolt and Nut Association of Great Britain, supported by the Rivet Association. The makers co-operating in the application, according to the statement of case, manufacture over 80 per cent. of the iron and steel goods defined in the schedule at present produced in Great Britain. It is claimed that the production of bolts, nuts and rivets is sufficient to satisfy all home-trade demands. The total imports of iron and steel bolts and nuts (including screws for metals) into Great Britain and Northern Ireland have increased from 6,142 tons, of a declared value of £172,405, in 1924 to 13,660 tons, valued at £273,300, in 1928, while the average price of these imported goods has dropped in the same period from £28 1s. 5d. to £20 0s. 2d. per ton. These bolts, nuts, etc., it is stated, are dumped into this country by foreign competitors, who are enabled to do so owing to their low wages cost and depreciated currencies, and all the goods are delivered into this country at prices with which the trade finds it impossible to compete. The growth of foreign competition is a serious matter to the bolt, nut and rivet trade.

It is further stated that it is practically impossible for any person not directly engaged in the trade, by superficial examination, to distinguish between British-made and imported iron and steel bolts and nuts. It is possible, at the time of manufacturing, to apply a mark of origin effectively without injury to the products. It is proposed to exclude from the application bolts and nuts, etc., which are imported as integral parts of other goods—such as motor-cars, machinery, etc. It is asked that the iron and steel goods defined in the schedule should be required to bear an indication of origin at the time of importation and of sale or exposure for sale.

The application covers blank and screwed bolts, nuts and rivets of every description; blank and tapped nuts, hexagon and square; square or hexagon set screws; square or hexagon head coach screws; and boilermakers' and engineers' studs, all of iron and steel.

Metallic Reinforcement Material.

An application for a marking Order has also been made in respect of metallic reinforcement used for reinforcing concrete, including all classes of meshwork, or lattice, helicals, spirals, stirrups, hoops and connecting links. The applicants in the case are the Reinforcement Manufacturers' Association, Limited, whose members interested in this application, it is stated, represent substantially the whole of the manufacturers of concrete reinforcement materials of the United Kingdom.

Copies of the statements of case in connection with both these applications have been circulated by the secretary of the London Chamber of Commerce to members of the Iron, Steel, Tinplate and Metal Merchants' Section of the Chamber, with the intimation that any grounds for opposition must be submitted to the Standing Committee of the Board of Trade before the end of this month.

Modern Steel Castings.

BRITISH AND FOREIGN PRACTICE COMPARED.

Mr. F. J. Hemming (Wednesbury) spoke on the general foundry aspect of steel-castings production, and Mr. D. Wilkinson (Northfield) discussed light green-sand motor-car castings, at a meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen held at the Chamber of Commerce, Birmingham, on December 13. Mr. E. H. Tyson (Branch-President) was in the chair.

MR. HEMMING said the steel foundry industry in this country was very much smaller than that of the Continent and America. So far as he could gather, the Continent—Germany, Belgium and Czecho-Slovakia—produced somewhere about half a million tons of castings a year. Their market was such that the production was to a much greater extent of a repetition character than was the case in this country. They were enabled to secure work, in the first place, owing to their low wage bill. The production of carbon steel castings in America was something like 1½ million tons per annum. The growth of that output was very interesting from the point of view of their melting practice. In 1898 their production of open-hearth castings was 135,000 tons; by the converter process 4,000 tons and crucible and miscellaneous 9,000 tons. By 1910, open-hearth castings had reached 950,000 tons; electric totalled 1,500 tons; converter 65,000 tons and crucible and miscellaneous 20,000 tons. In that year they had the introduction in America of the electric process. In 1920 the production by the open-hearth process totalled 1,100,000 tons, electric 175,000 tons, converter 117,000 tons and crucible and miscellaneous 5,000 tons. In 1928 the tonnages were:—Open-hearth 950,000, electric 390,000, converter 32,000, crucible 1,000. A review of those figures indicated, he thought, what would happen in this country as electric power became cheaper. In this country the output of steel castings was somewhere between 100,000 and 150,000 tons a year. They were sometimes criticised for not doing more by way of the modernisation of plant, but they were limited in that direction by the comparatively small market available to them. Of the plants in this country seeking the 100,000 tons or so of business, a great many were at least 50 years old, and practically no steel foundries were being erected at the present time. The fundamental fact was that the trade had so grown up that steel founders in this country existed to execute miscellaneous orders for the general engineer, while owing to wage rates they were compelled to stand aside from some of the more attractive repetition lines. In a foundry such as the one with which he was associated, their output ranged from castings weighing a few pounds up to practically 20 tons. The difference in the range of production was a tremendous handicap in competitive force. He thought the salvation of the British steel foundry trade would be the application of some of the principles governing the American trade—for example, some initiative in the trade to encourage customers to divide their orders into the types of castings to which a foundry was best suited. In America, if a man received a schedule of castings to quote for, he would recommend his competitor for that portion which did not suit his own practice. Groups of foundries in America combined for research and for the exchange of views, and the aim was to secure a correct balance.

In the modern foundry the tendency was to take every pattern put into production through the pattern shop so that it was gated and headed and a full list of instructions was issued for the process through which the casting had to go. In his own case, they had recently established a sand laboratory, which gave them complete control of the sands throughout the foundry. The testing of sand was very much like the testing of metal. They took test-pieces of their sands and tested them for permeability. Within a few weeks they would be able to test them for fusion with a small electric furnace. The practical foundryman was as scientific with his fingers as were instruments, but he thought that actual testing was good for the discipline of the craftsmen in the foundry and should ultimately yield good results. He did not imagine, however, that the addition of such sand-testing apparatus was going to eliminate troubles with castings. If they were producing miscellaneous castings they had to use to some extent varying qualities of sand.

As to the development of the use of air in the foundry, Mr. Hemming said that in American foundries the use of air was amazing. The moulder was equipped with a pneumatic rammer; he had an arrangement for blowing the loose sand out of the mould and for other purposes. All these things were very hard to introduce into the miscellaneous foundry. They certainly were developing, however, apart from machine moulding, where air was largely used.

Speaking of conditions on the fettling floor, Mr. Hemming recalled the difficulty they had years ago on the introduction of pneumatic hammers. To-day, he said, the men would not work if anything went wrong with the wind pressure. In the case of a big casting he did not see how the present methods of fettling could be extensively modernised. There might, however, be considerable modernisation so far as very small castings were concerned. With regard to the removal of the gates and heads from castings, Mr. Hemming said that a steel casting when it was in the rough state was furnished with a runner and one, two, three or more heads according to the type of casting. The removal of those heads was always a very costly and difficult process, as it tended to disfigure the casting sometimes. It must be remembered that it was necessary to put a head on a casting in such a manner that the soundness of the casting was aimed at rather than to make it easy to remove the head. To-day they had practically changed over to the use of oxygen, having a central oxy-acetylene station with pipes laid down the fettling floor. That method, although more expensive, he thought had come to stay because it would speed up production in foundry work generally.

Future of Green Sand Castings.

MR. D. WILKINSON said that years ago it used to be considered a very difficult matter to get a sound green-sand steel casting. Developments had gone on so rapidly, however, that to-day it was quite as easy to get a sound casting in green sand as in dry sand. Satisfactory results could only be obtained by great care, although once they had standardised their methods the whole thing tended to become more or less automatic. The requirements for a green-sand casting in steel were on the whole exceedingly simple, but while simple they were not always easy to attain. In the first place, they did not make the sand. Even if they used what was termed synthetic sand, they had to take it as it came from the quarry, and sand as delivered from the quarry varied very considerably. The first requirement of a green sand for steel castings was uniformity of grain-size. Some sands, on sifting or elutriation tests, showed grains of varying size right through the composition, and there was often a quantity of fine silt. The second requirement was a grain shape which was well rounded and smooth, not angular and rough. This gave much higher permeability. The third requirement was a bonding material which was highly plastic with a low percentage of water. This really meant a clay that was pure except that it carried a quantity of colloidal ferric oxide. Except for the ferric oxide, the nearer the clay approached a pure hydrated aluminium silicate the better the bond it would give with a low amount of water. If they took an air-dried sample of a clay of this character and compared it with an air-dried sample of a low-grade one, it would be found that much less water would be required to make the better-class clay perfectly plastic and coherent than would be required in the second case. With the low-grade clay, a small amount of water would yield a crumbly material with a low degree of plasticity, although a larger addition of water might give a perfect plasticity. If they had a grain of a smooth, uniform size and coated all the grains perfectly with a clay that developed its maximum plasticity with a low percentage of water, they had a sand that could be used in a relatively very dry condition and yet one that would have a first-class green bond. Such a sand would be ideal for green-sand steel castings. The uniform smooth grain-size and freedom from silt gave maximum permeability. The small amount of water reduced the amount of steam generated and the volume of hydrogen gas formed, and so the liability to blowing was cut out. The strong bond reduced the liability to scabbing, despite the high temperature of the metal, and held up the mould to shape during the brief interval before the steel set.

Heat Treatment Desirable.

As the best qualities of the metal were not developed on solidifying from the completely molten condition, it was seldom advisable to put a steel casting into service without annealing or some other form of heat-treatment. Especially was this the case if the sections of the casting were so unequal as to cause shrinkage stresses, due to unequal rates of cooling and contraction. Some castings were of such design that these stresses were very severe and would occasionally lead to cracks forming even after the casting had completely cooled. The impression sometimes prevailed that the relief of these stresses was the chief function of annealing or normalising. It certainly was an important function of these processes, but by no means the only one. The principal result was a refining of the granular structure of the metal, so that from being coarse and irregular it became fine and uniform. Care must be taken to heat up the castings to the correct temperature. Underheating could do considerable harm, and in the case of a low-carbon steel might make the casting quite useless for any important work. The temperature should be high enough to enable the whole of the carbide to go into solution. This temperature varied with each 0.1 per cent. carbon content. If a 0.15 per cent. carbon steel was heated to, say, about 700 deg. C., instead of at least 900 deg. C., the effect was rather disconcerting. Practically all the test figures would be reduced. The only figure that might not be reduced was the elongation, but even this he had known considerably affected. The cause was not far to seek. The heat was insufficient to take the cementite lamellæ of the pearlite masses into solution, but it was sufficient to cause these lamellæ slowly to coalesce until they formed small granules of cementite, leaving practically pure ferrite as the ground mass.

Mr. Wilkinson expressed the conviction that ultimately many of the heavier castings made in dry sand would be made in green sand. The whole question turned on having sufficient strength to stand the rush of the molten metal and high temperature to which it was subjected without giving off more steam and hydrogen gas than could be accommodated by the porosity of the mould itself. It was only a matter of research to find out the conditions, and ultimately he fully expected that they would get repetition steel castings of very considerable weight made in green sand.

Nickel in the Iron Foundry.*

By Arthur B. Everest, Ph.D.

Somewhat reluctantly, but nevertheless surely, engineers are coming to realise that cast iron is, after all, not the Cinderella of the metals, since it possesses some properties which render it superior in many respects to its more refined rivals, and is, moreover, capable of improvement and control by scientific means. Thus, in the past few years there has been a growing revival of interest in the development of this material and the evolution of new processes and methods of attaining improved properties in it. The possible improvement and modification of the structure of cast iron by the use of alloy additions has been of interest to foundrymen for many years—in fact, early patents covering the use of such additions can be found dated back to over a century ago. It is only comparatively recently, however, that, in answer to the ever-growing demands of modern engineering, detailed attention has been given to this field.

As a result of investigations, one finds amongst the metals now usefully employed in the foundry, other than those normally occurring in cast iron, principally nickel, chromium, copper and molybdenum, whilst small quantities of aluminium, titanium and vanadium are employed rather as scavengers and deoxidisers than as true alloy additions. Of these, nickel is proving in many respects the most generally useful, and, following on very thorough technical studies of its action on the constitution of cast iron, one finds its application in industry becoming daily more widely spread.

* The basis of Papers delivered before the Institute of British Foundrymen, Glasgow, November 9, and Manchester, December 7, 1929.

General Effects of Nickel on Cast Iron.

As the result of extensive researches, it has been established that when nickel is added gradually to a white iron, it first renders the iron sound, and further additions graphitise the iron, turning the structure from white, through a mottled condition, to grey. Thus, in the first place, nickel is seen to act like silicon, but the action has been found to be more feeble. This first effect of nickel consequently leads to the elimination of chill in a casting, thereby softening thin sections and improving machinability where trouble with hard spots at corners and edges and in thin sections of the casting is liable to occur.

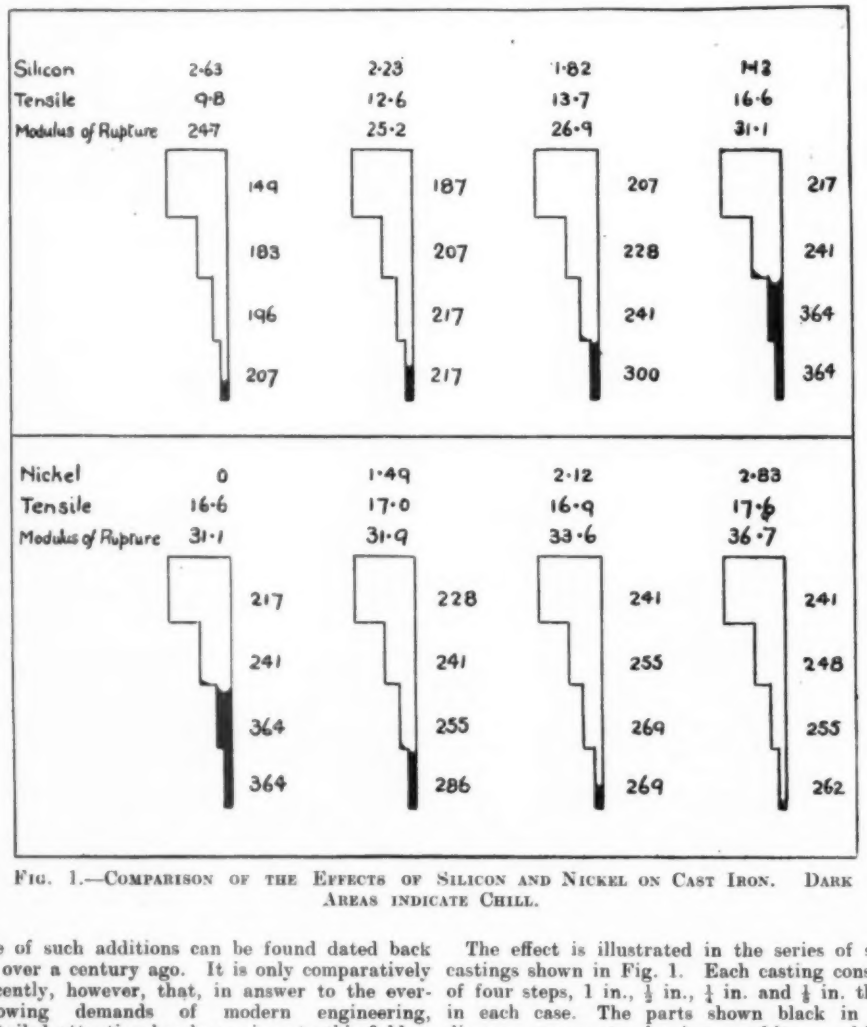


FIG. 1.—COMPARISON OF THE EFFECTS OF SILICON AND NICKEL ON CAST IRON. DARK AREAS INDICATE CHILL.

The effect is illustrated in the series of step castings shown in Fig. 1. Each casting consists of four steps, 1 in., ½ in., ¼ in. and ⅛ in. thick in each case. The parts shown black in the diagram are parts showing a white or chilled structure in the castings. The general influence of increasing nickel is illustrated in the lower, and of increasing silicon in the upper, series. The reduction of chill in each series is illustrated, this being naturally associated with a decrease of Brinell hardness in sections where chill is found.

In its effect on thin sections, nickel is thus seen to act in a manner very like that of silicon. A marked difference in the action of the two elements is, however, revealed by a study of their effects on the thick sections of the casting. As expected, the addition of silicon results in softening in the heavy sections of the casting, so that progressive softening in all sections results. In the nickel series, however, it is seen that increasing nickel produces increases in the hardness of the heavier sections—an effect opposite to that of silicon, and of the most vital importance to the foundryman. Accordingly, when nickel is added to an iron as shown, softening of the thin sections and hardening of the thick sections take place simultaneously, resulting in an equalisation in hardness throughout the casting. Typical hardness curves for an ordinary iron and for the same after the addition of nickel are shown in Fig. 2, and illustrate well the equalisation resulting from the nickel addition.

Effect of Si and Ni on Chill.

The curves in Fig. 3 are taken from the figures in Fig. 1 and emphasise the effects of silicon and nickel on chill and hardness. The curves serve to illustrate further that by replacing silicon by nickel great benefit results, for in an iron of about 2.5 per cent. silicon content the effect of reducing silicon is that the hardness and strength of the casting progressively improve, but the chill depth increases and the casting becomes unmachinable. The addition of nickel to the low-silicon iron again reduces the depth of chill and softens the thin sections of the casting, but the hardness of the thick section continues its upward trend initiated by the reduction of silicon. Thus, while restoring the machinability

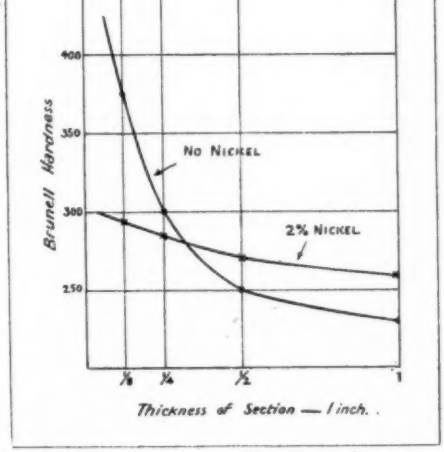


FIG. 2.—COMPARISON OF NICKEL ON HARDNESS OF SECTIONS IN A CASTING.

of the iron, and obtaining once more low depth of chill, the thicker sections of the castings are rendered hard, strong and dense; moreover, great uniformity of structure is obtained as indicated by the small hardness difference between the thick and thin sections. This combination of properties attained by the use of nickel is unique and could not be expected normally to be obtained by any other means under ordinary casting conditions.

High Brinell-hardness figures are generally associated with high strength and density in the metal, and it is accordingly not surprising to find that in the series illustrated in Fig. 1 the strength figures follow the same tendency as the Brinell figures. Thus the test-bars, which are representative of the heavier sections, show progressive decrease in strength with reduction in chill in the silicon irons, whereas in the nickel series the strength is constant or increases slightly under similar conditions. Thus, comparing irons of equal depth or chill in each series, there is found a large advantage for the nickel iron as demonstrated by the strength figures given. Again, employing hardness as an index of the general condition of the metal, it is clear that, in view of the greater uniformity exhibited in the various sections, the strengths of the sections will show less variation from

section to section. In this respect, again, the nickel iron shows up to advantage when compared with the ordinary product.

It has been demonstrated that nickel acts like silicon in eliminating chill, consequently the two elements are replaceable. In many instances improvement in the strength and density of cast iron can be effected by a reduction in silicon, but trouble is then encountered with unmachinability due to chill and hard spots, as indicated by the increase in chill depths shown in Fig. 1. The addition of nickel to irons in which silicon is reduced, leads not only to further improvement in strength and density, but also restores the machinability of the casting.

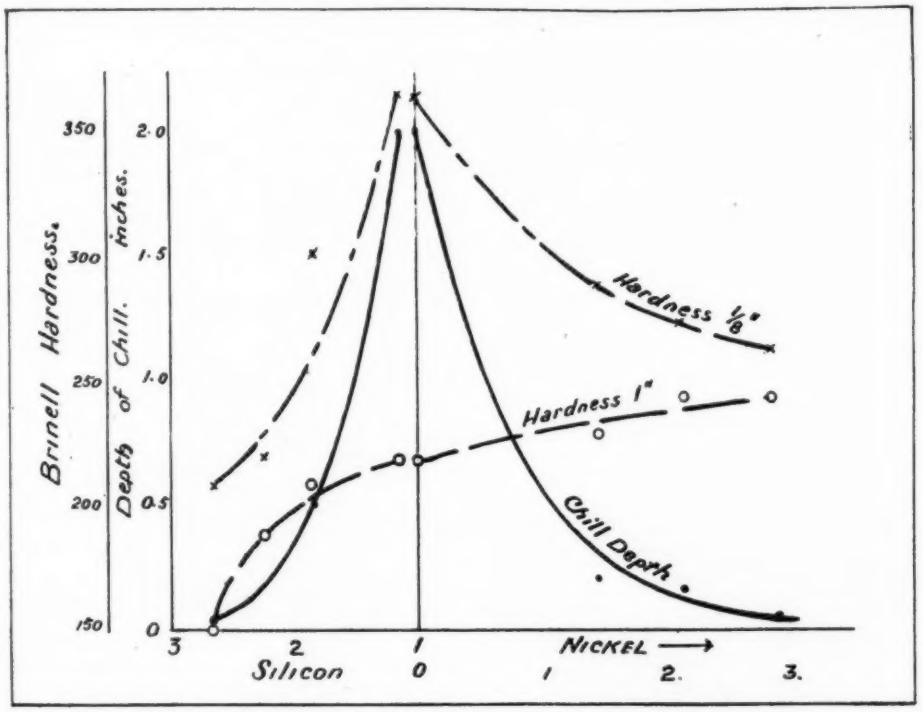


FIG. 3.—EFFECTS OF SILICON AND NICKEL ON CHILL AND HARDNESS.

Hardness of Ni and Ordinary Irons.

Fig. 4 shows hardness curves for ordinary and nickel irons. Two limits of Brinell hardness are indicated: above the upper limit, the irons may show chill spots and tend to be commercially unmachinable; whilst below the lower limit, soft and open-grain irons are obtained, with resulting trouble in bad wear, porosity and so on. Clearly, these limits are arbitrary, and their actual values will be decided by types of iron and casting, machine-shop practice and other considerations. Curves A and B represent ordinary irons; of these curve A approaches more nearly to general practice, giving a casting with the required machining qualities, but with the heavy sections showing undesirable softness and openness. Curve B, however, represents an iron which in the same casting would give greater density and strength in the heavy sections, but which will give machining troubles. Such effects would result from the hardening of iron A by the reduction of silicon.

Curves C and D illustrate the effect of adding about 1 per cent. of nickel in each case. The usual effect in decreasing the slope of the curve is seen, and both curves C and D represent castings whose sections would fall entirely within the useful range of hardness and structure. In the case of curve C, the heavy sections have been densened, but it will be noticed that the thin sections are unnecessarily soft from the machinability point of view, whereas the best results throughout are shown by curve D. Curves A and D both represent irons of an equivalent depth of chill, each giving castings which are just machinable. Comparison of these curves, however, demonstrates the superior hardness and density of the nickel iron.

These curves emphasise the logical method of the use of nickel. Starting with a base iron such as A, if nickel is to be applied, the first step should be to harden the iron by reducing silicon, as in curve B. Nickel is then added, giving results as shown by curve D. Such procedure gives the full benefit of nickel, but, as suggested by curve C, some benefit in densening heavy sections may be obtained by the simple addition of nickel alone to the iron.

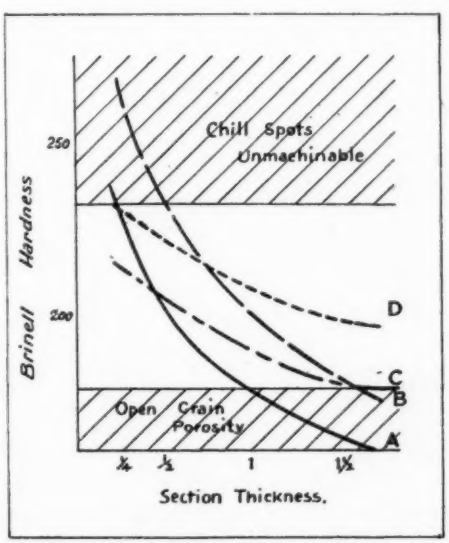


FIG. 4.—HARDNESS VARIATIONS IN ORDINARY AND NICKEL CAST IRON.

Adding the Nickel.

Referring briefly to the actual addition of nickel, it is emphasised that benefits such as described may be obtained usually by the addition of 1 to 2 per cent. As previously demonstrated, more than 4 per cent. of nickel should not be added for these purposes, since such additions commence to modify the structure of the iron, rendering the pearlite martensitic, and consequently causing the whole casting to become hard and unmachinable.

Up to about 2 per cent. of nickel may be added in the ladle of iron, or in the cupola spout, the low melting-point nickel shot, known as F shot, being recommended for this purpose. For tonnage production or for the incorporation of more than 2 per cent. of nickel in the iron, it is recommended that the addition should be made in suitable form with the furnace charge,

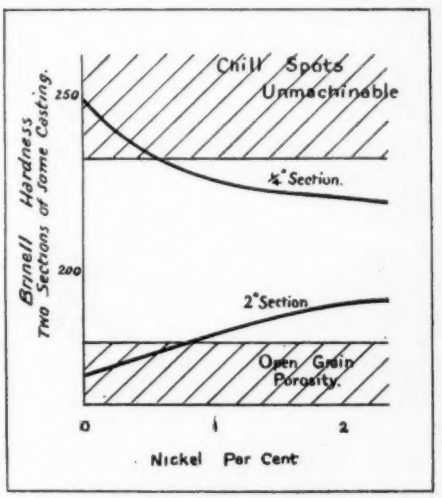


FIG. 5.—EQUALISATION OF STRUCTURE BY USING NICKEL.

this being practicable, since there is no loss of nickel by oxidation in melting, and ready alloying is obtained.

Practical Results from the Use of Nickel.

The influence of nickel on hardness and strength has already been emphasised in this Paper, and reference has been made to its equalising action on the various sections of a casting. This latter point may be further demonstrated by a curve of the type shown in Fig. 5, in which the result of adding nickel to a casting containing sections of ¼ in. and 2 in. occur. The remarkable effect of nickel in equalising the structure of iron is clearly brought out, and it is seen that, whereas in this particular case the ordinary casting was giving trouble with machinability in the thin sections, yet it was too weak and open in the heavy section. The addition of 1 per cent. nickel, it is seen, has brought both sections within the useful range of hardness.

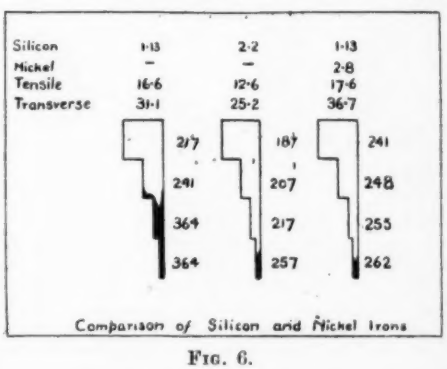


FIG. 6.

It is evident from such an example that the nickel iron has a much greater latitude than has the ordinary iron, and provides the foundryman with a material which will enable him to steer more easily a safe course between trouble with

machinability, on the one hand, and open grain, on the other. Moreover, it is evident that if by the use of nickel both sections of such a casting can be brought well within the useful range of hardness, then minor variations in composition, such as inevitably occur in ordinary foundry practice, will not have the deleterious effects normally associated with them.

Examples of the elimination of chill have been given elsewhere,* confirming the results of fundamental research carried out in many countries. Reference to the relative effects of nickel and silicon on the chill depth obtained in cast irons clearly establishes the fact that for ordinary compositions about three parts of nickel are equivalent to each part of silicon, and, when substituting nickel for silicon, such a ratio can in general be safely employed. A comparison between a nickel iron and a corresponding silicon iron is given by the tests shown in Fig. 6. In this figure the first casting illustrates the properties obtained in a low-silicon base iron of reduced chill obtained by increasing silicon, whilst the third casting shows the properties of

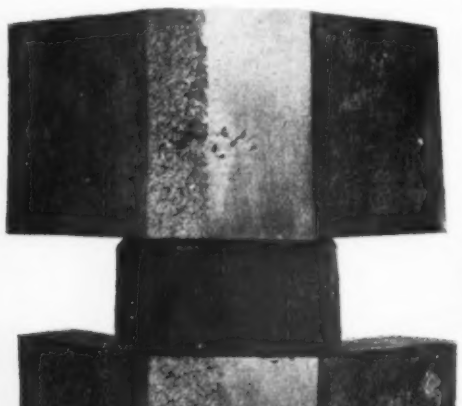


FIG. 7.—TEST CASTINGS TO SHOW EFFECT OF NICKEL ON POROSITY.

an iron obtained by adding nickel to the base to give the same depth of chill as obtained in the higher silicon iron. It will be noted that the hardness figures are entirely in agreement with the remarks made earlier in the Paper, and a very useful increase in tensile strength has been obtained in the iron for the same depth of chill when comparison is made between the higher silicon and the nickel-iron castings.

Separately-Cast Test-Bars.

A great deal has been heard recently about the misleading results obtained from tests on separately-cast bars, and engineers and foundrymen alike realise that these tests are by no means representative of the strength of metal in a casting. The "cast-on" bar likewise can never be satisfactory, but will give a compromise between the actual strength of the casting and the separately-cast bar. The full advantage of nickel is seen in the heavier section of the casting, and in virtue of its equalising action on structure variation in strength from section to section is minimised. Accordingly it is being found that, whereas the use of nickel in cast iron, for a casting may show an improvement in strength of but a fraction of a ton, nevertheless the improvement in the heavy sections is generally very appreciable. The result of this is that, when nickel is employed, the test-bar strength becomes much more truly representative of the actual strength throughout the casting.

It is well known that in engineering design for machinery castings the strength of cast iron has to be taken for calculation as 1.5 tons per square inch. This is based on an actual strength of 4 or 5 tons in the larger sections, and subsequently a substantial factor of safety is allowed. It is clear that this figure can be raised by employing modern methods, and the use of nickel is being demonstrated to be effective in this connection. Moreover, when engineers can be persuaded to raise this figure, advantage to themselves and the foundrymen will at once accrue through reduction of sections, for in all classes of cast iron the absolute strength is improved by the more rapid cooling obtained in the lighter section, and better castings will result.

American Loco-Cylinder Practice.

It is interesting in this connection to note the American practice used in testing iron for locomotive cylinders. A large test-bar is cast, this being four inches in diameter. A test-piece, 1.25 in. dia., is then machined so that the test-piece represents the metal in the core of the test-bar. It will be appreciated that this is a very severe test of the quality of the metal, and in this case it is being found that nickel in the cast iron leads to the obtaining of the desired result, both in giving stronger and denser castings and in giving test-bars truly representative of the castings which at the same time readily meet these exacting specifications.

FIG. 8.—PETROL-PUMP BODY CASTING.

In tests carried out recently it was found that in bars cast 6½ in. in diameter great uniformity and high hardness and strengths were obtained in the centre of the sections when nickel irons of reduced silicon content were employed. Ordinary iron cast under the same conditions showed the usual soft and open structure in the centre of the castings.

Practical examples of castings made in nickel iron have been given elsewhere,* but as a typical example reference may be made to the case of air-cooled automobile cylinders in which, by the addition of nickel to an iron giving white fins in the casting, these fins are rendered grey, and consequently tough, at the same time as the heavier-sectioned cylinder barrel is itself rendered harder and denser. In a similar manner, nickel is repeatedly applied in automobile castings and in castings required to have high hardness values and strength.

Effect of Nickel on the Foundry Qualities of the Iron.

So far in this Paper consideration has been given to the fundamental influence of nickel on the mechanical properties of iron and to the practical applications of the material in virtue of these improved qualities. Some reference should be made, however, to the influence of nickel on the foundry qualities of cast iron. It is found that, by the addition of small percentages of nickel, the casting qualities of the iron are not affected to any appreciable extent, and that iron in the ladle which will run a satisfactory casting, when poured directly, will give a casting with equal facility when nickel up to 1½ per cent. has been added as the iron leaves the cupola or enters the ladle. The contraction and fluidity of the alloy iron are found to be very similar to those obtained in the ordinary material.

Elimination of Porosity.

A result of the use of nickel, and its equalising action on the sections of a casting, which is of the utmost importance to foundrymen, is that nickel tends definitely to the elimination of porosity in heavy sections, or in parts of a casting where, through the junction of sections, there is a tendency to sponginess. Most foundrymen are troubled at some time or other with this, especially if castings are subjected to any type of pressure test. The type of porosity frequently met is shown in the centre of the top "X" shaped casting illustrated in Fig. 7. This casting was designed to illustrate this trouble, each arm being 4 in. long by 3 in. deep by 1 in. wide, the radius between each pair of arms being 1 in., the example demonstrated being cast in an ordinary iron. As a result of experience, it has been found that nickel definitely tends to the elimination of this type of trouble, due, it is believed, to its equalising influence on the various sections of the casting, and its influence on the freezing range of the metal. In the present instance, a sound casting, as illustrated by the lower example, was obtained by the simple addition of 1 per cent. of nickel in the iron. Normally, for the elimination of porosity, it is recommended that before the nickel is added a reduction in silicon is made, this usually tending itself towards the elimination of porosity, while the subsequent addition of nickel further assists this factor and restores the machinability of sections of the castings which may have tended to have become excessively hard.

FIG. 9.—AMMONIA STRAINER BODY.

Such an application as above is elaborated in the case of pistons of various sizes, where soundness in the pin bosses is required in castings machinable along the length of the skirt. Other examples of the elimination of porosity have been given, as in the case of plates subjected to pneumatic pressure, locomotive cylinders, compressor bodies and such similar castings.

Petrol-Pump Castings.

Further illustrations occur, as in the case of petrol-pump bodies, as shown in Fig. 8. It is well known that petrol will find porosity in

* "The Practical Application of Nickel in Cast Iron," A. B. Everest, FOUNDRY TRADE JOURNAL, July 25, 1929.

* *Loc. cit.*

castings which have proved sound under water-pressure test. Consequently, strictest care must be taken in obtaining sound castings for such service. The use of nickel has enabled pump bodies of the type illustrated to be cast without trouble and to pass satisfactorily the tests required. Ammonia is also known to give excessive trouble in leaking through castings, and here, again, the use of nickel iron has led to the minimisation of this trouble. An ammonia strainer body is illustrated in Fig. 9.

Cylinder Heads.

These two castings are of a comparatively simple nature, and the pressure-tightness is of the first consideration. In other castings, however, such as in the case of cylinder heads and valve parts such as are illustrated in Figs. 10

FIG. 10.—CYLINDER-HEAD CASTING.

and 11, good machining and wearing qualities are required in the iron, as well as pressure-tightness. In all these examples the desired results have actually been obtained on a production basis by working an iron with the silicon 0.2 to 0.3 per cent. lower than that which would normally be employed, and by adding to the iron 1 to 1½ per cent. of nickel. It is found that the addition of nickel alone gives some benefit, but

FIG. 11.—COMPRESSOR-HEAD CASTING.

for it to be most effective the simultaneous reduction in silicon is recommended. Under these circumstances it is often found desirable to use a nickel to silicon ratio somewhat higher than 3 to 1, as indicated by the figures given in the present example.

In castings of this type, chills and denseners are often employed for controlling porosity, but in these cases subsequent examination of the casting will often reveal the fact that the chill has done no more than drive the porosity from one part of the casting to another. Nickel, by eliminating the actual tendency to porosity, not only will enable the chills and denseners to be omitted in the mould, but will restore confidence in the soundness of the casting by the fact that even in the absence of chills porosity is absent in the parts where it is normally expected. Examples in which chills have been found unnecessary after the addition of nickel are given by castings of the type of gear blanks and couplings which tended to show porosity in the bosses or rims opposite the ends of the arms.

Summary.

The fundamental influence of nickel is, as in the case of silicon, to tend to the formation of graphite, thus rendering a white iron, grey, and also to eliminating chill and hard spots in hard grey irons and thereby improving their machinability. The addition of nickel to a grey iron, however, tends to refine and harden the matrix while retaining its machinability, thus in this respect it acts in a different sense to silicon, which under similar circumstances progressively softens and opens the iron.

In view of these two actions, nickel will soften the thin and chilled sections of a casting, rendering them machinable at the same time as it hardens and refines the thick sections, thereby producing a much greater uniformity of structure in castings of varying section. For practical purposes, not more than 4 per cent. of nickel should be added to cast iron to produce the results described. An addition of 1 or 2 per cent., however, is generally sufficient to produce an economic benefit. The nickel may be added in the cupola, or by suitable methods to the ladle of molten iron.

The practical results of such additions have been considered, and it has been shown that in improving machinability each three parts of nickel are equivalent to one part of silicon for normal compositions. Consequently iron of a lower silicon content should be employed when nickel is used. This initial lowering of silicon leads to an improvement in hardness, strength and density in the iron, but the casting becomes unmachinable; the addition of nickel restores the machinability of the casting and at the same time further increases the hardness and strength. Thus, making a true comparison between a nickel iron and an ordinary iron of equivalent silicon content and therefore of equivalent chill depth under given conditions, it is found that for equal machinability the nickel iron has greatly improved mechanical properties, the strength in heavier sections being in most cases greatly increased, and the hardness in thick sections by sometimes 50 points Brinell. The rational method of employing nickel accordingly is to add it to an iron with silicon content reduced below normal.

Nickel may be employed to increase the hardness and closeness of cylinder walls in automobile castings, leading to improved wear, while machinability is unaffected, or actually improved. It is used also to obtain great density throughout very heavy sections of castings and to produce high strength castings, which are readily machinable. Through its action on cast iron, nickel is found to increase the density and pressure tightness of heavy sections, and tends definitely to the elimination of porosity in these sections and at the junctions of sections in a casting. It is finding special application in castings for handling ammonia, petrol, carbon dioxide, etc. Nickel thus gives an iron of greater latitude, enabling the foundryman to steer a safe course between unmachinability, on the one hand, and porosity and open grain trouble on the other, and leads to the elimination of scrap castings from these causes and to greater uniformity of product.

SCOTTISH DISCUSSION.

The CHAIRMAN (Mr. H. Winterton) said that Dr. Everest had given them a most instructive and interesting lecture. He was making notes when Dr. Everest was dealing with faults in the castings, and it occurred to him that probably more careful handling of the sands would give the same result. He knew that sometimes the sand-handling process went astray.

Enhanced Tensile Strength.

MR. JOHN CAMERON (past-president of the Institute) said that he thought that Dr. Everest had put the question of nickel in cast iron to them in a very clear manner. He had shown what nickel additions of various percentages could do. He himself had had little necessity for using nickel, but through getting friendly with Dr. Everest he became interested in the nickel question, and had experimented. He found that as far as his experiments went nickel did give the results which had been mentioned; he would quote as an example an experiment with the very highest class metal made at his works, the tensile of which was 19 tons, and they had been unable to get above that figure until they tried the addition of nickel, when they got 23 tons per square inch, along with improvement with strength there was an improvement in the grain. Nickel had the effect of refining the grain of the iron, probably due to the reduced silicon content. If they did as Dr. Everest had said and reduced the silicon they achieved the results. He thought that the practical foundrymen should take every opportunity to experiment with nickel and find out what it really would do. The use of nickel in cast iron was only in its infancy, but in course of time we should discover what nickel alone or in conjunction with a little chromium would do. That nickel gave the results Dr. Everest claimed there was no doubt.

MR. P. MCFARLANE asked if Dr. Everest could say what effect the addition of nickel to cast iron had on the skin of the casting.

DR. EVEREST replied that he thought as a rule the skin of the casting was more a function of the sand condition than of the metal. He would not expect any difference in that respect due to nickel.

Corrosion Resisting and Cast Iron.

MR. RUSSELL asked if Dr. Everest could give any comparative data as to the relative corrodibility of iron with and without nickel. Would he also state the extra price of the casting per cwt.?

DR. EVEREST replied that he could not hold out any hope that there would be appreciable improvement in the corrodibility, nickel does not reduce corrosion for a given grain size, but they did find an overall improvement due perhaps to the production of a finer grain structure. As regards the cost the addition of 1 per cent. nickel increased the price by approximately 2s. per cwt. He would point out that in considering the cost it must be remembered that when nickel was used it was for removing trouble, and it was necessary to make out a balance-sheet, taking account of porosity, strength, elimination of wasters, and the use of common iron instead of refined metal. He knew of a case where a great deal of trouble was experienced in the casting of carbon dioxide compressor cylinders, and it was found necessary to use refined iron. By the addition of nickel the castings were obtained without any trouble. The firm now use ordinary iron with nickel, and the metal costs less than in the days when refined iron was used.

Heat-Resisting Irons.

DR. J. W. DONALDSON said that he could not say very much about the examples that Dr. Everest had given as he was more particularly interested in larger castings, such as required for Diesel engines. He liked the very clear way in which Dr. Everest had explained both the laboratory and practical aspects of the case. He was particularly interested in the curves showing the relationship of hardness and strength and also the further curves derived from these experiments, which are from the engineer's point of view of great importance. It was true that by adding nickel to cast iron there was obtained a range of irons with good machinability, but there were other things of even greater importance to be considered, such as growth and carbon decomposition. He would be glad to have some information on these points.

XUM

DR. EVEREST thought that Dr. Donaldson more than anyone should realise the very complicated nature of that question. He had not raised that point in the paper, and had no wish to do so. He knew of a case where an annealing box made from iron containing nickel had given very good results through a definite temperature range. It was not yet known nor certain what the critical range was, and all features had to be very carefully considered before it was possible to say what the result would be.

Nickel and Porosity.

There were two applications of nickel that were firmly established, namely gear-blanks and couplings. In casting gear-blanks it has been found that there was a grave danger of obtaining porous patches at the root of the teeth, but the addition of nickel eliminated this trouble. One firm used to make gear-blanks for their own use only, but when they adopted the nickel iron they were so successful that they made them for other firms and thus started practically a new business. The amount of nickel added was only 1 per cent. He knew also that firms in the Scottish area were using nickel for couplings with complete success.

MR. J. LONGDEN said that Dr. Everest had given them a very closely-reasoned lecture, and it was difficult to see how the results arose. With the stepped bar experiments no one could quarrel, but in regard to the cross-shaped bar that Dr. Everest had shown, one cast with ordinary metal was porous and the one with nickel solid. He was not convinced the same result could not be obtained by adjusting the size of the runner. Dr. Everest had said nothing about the way in which the castings had been run or the temperature of pouring. Possibly the runner had been cut by the moulder. Extremely diverse results could be obtained by varying the runner and the temperature. Dr. Everest again had shown a cylindrical bar which had given a remarkably regular hardness all through, but if he cast a bar 1 in. sq. by 12 in. long and tested the hardness would the same result be obtained? Had he any evidence to show more clearly the nature of the metal in such a case? Dr. Everest had presented a good deal of evidence from the stepped bar casting, and had deduced results very cleverly to show that a casting would result as he expected, but had he any real experience of heavier castings, such as locomotive cylinders and the like.

Regarding gear-blanks, he had had much experience of casting these, and some time ago he tried experiments with nickel. He was in the habit of casting gear-blanks with metal containing 1.3 per cent. silicon and getting good results. He cast others with metal containing 1.0 per cent. silicon and some with 1.0 per cent. nickel added, and obtained them all solid. The question he would like answered was how does nickel aid solidity? He cast a blank 5½ in. dia. and 4 in. thick, and the mould was filled with liquid metal at the top, the blank was piped as it would be expected because there was not enough metal to fill the pipe, obviously such a metal shrinks on solidification. How is it that metal with nickel added becomes more solid? He had cast blocks which appeared quite sound, but on cutting a section and examining under a lens found a large number of little cavities which he thought were due to shrinkage.

Testing for Porosity.

DR. EVEREST, in reply to Mr. Longden, said that his test-bars for porosity were made as far as possible under the same casting conditions. He would be very glad if Mr. Longden could give him a reliable test for porosity. He had carried out experiments and tried to illustrate the results by test-bars. The cylindrical bar was not a test-bar but was designed to be cut into discs. It had not been possible to cast one successfully without nickel. Regarding locomotive cylinders, these have been tried and successful results obtained; similar results were obtained in cylinder covers which carry a lump giving great trouble. He knew of a foundry where ten were scrapped with ordinary metal, but when nickel was added they obtained sound castings. The use of nickel was still young, and its applications should come in one by one. He did not say that nickel iron had no shrinkage, but he did say that nickel equalises shrinkage and leaves regular grain in all sections.

MR. SHANKS asked with regard to the higher percentages of nickel causing the passage of the metal to the martensitic range what difference it made to the hardness.

DR. EVEREST replied that the hardness went up to 500 Brinell. The metal would be very tough, but he had never tested it, and it would be difficult to do so on account of machining troubles. He thought that the metal would be found to be hard, tough and strong.

The CHAIRMAN, in proposing a vote of thanks to Dr. Everest, said they had had a most interesting and instructive lecture, and the fact that it had given rise to so many questions proved how thoroughly the subject had been dealt with. Dr. Everest, having acknowledged the vote, the meeting then terminated.

Taking Samples from a Blast Furnace.

A report on taking samples from a blast furnace at the Friedrich-Alfred iron and steel works of the Friedrich Krupp A.G. is given by HERR HUGO BANSEN, of Rheinhausen, in a recent issue of the "Archiv für das Eisenhüttenwesen." The following is a brief summary of the report.

Solid and liquid material was taken from the emergency-blast, main-blast and slag-tuyere levels of a blast furnace, making basic iron with a hearth diameter of 5.5 m., by means of a water-cooled pipe fitted at the end with a black-sheet metal cap. The composition of the iron thus obtained showed approximately the following percentages in the contents at the emergency-blast tuyere level (and the slag-tuyere level in brackets):—C, 1.32 (3.64); Si, 1.86 (0.45); Mn, 0.66 (1.58); P, 0.58 (1.80) per cent.

The reduction in the silicon content between the emergency-blast and the slag-tuyere levels is noteworthy. The behaviour of the silicon is considered in detail, and the uncertainty of its determination—previously pointed out by Mr. S. P. Kinney in Technical Paper No. 397 of the U.S. Bureau of Mines—is discussed. The analyses of the samples show great divergences, so that it appears justifiable to regard the samples as advance indications of a process in progress. Macroscopic views were taken of some of the samples.

Numerical investigations regarding the action of the reoxidation of silicon in front of the tuyeres on the heat economy of the blast furnace showed that such oxidation could not be considered detrimental. The result of tests which were adapted to a large extent to the conditions prevailing in the blast furnace showed that the quantity of carbon separated out on the decomposition of the carbon oxide was very slight in proportion to the quantity of carbon necessary for direct reduction. In conclusion, the question of the reduction of the silicon in connection with the separation of carbon is examined from a thermo-technical point of view.

Large American Steel-frame Building.—The Merchandise Mart of Chicago, now in course of construction, which, it is claimed, will be the world's largest building, will require 60,000 tons of structural steel, including 61,000 columns, girders and beams; 142 miles of pipe for the sprinkler system; 32½ miles of pipe for the steam-heating system; 40 miles of plumbing pipe; 9,504,000 sq. ft. of steel wire reinforcement for floors; 60 tons of wire for 30,000 lighting fixtures, besides many other materials in similarly large quantities, such as 29,000,000 bricks and 132,000 sq. ft. of glass.—"The Iron Age."

Book Review.

Melting Iron in the Cupola, by J. E. HURST. Published by The Penton Publishing Company, Limited, Caxton House, Westminster. Price 25s. 6d. post free.

The publication of this book brings the subject of cupola practice right up to date. Up to now, students either had to refer to a section included in a book on foundry practice in general, or refer to that by Edward Kirk, copies of which are difficult to procure, as it has been out of print for some years.

The reason for the excellence of this book probably lies in the fact that Mr. Hurst, as an Englishman, writing primarily for an American public, had to deal with his subject from a much wider angle than is usually the case.

The book is divided into eleven chapters, and we insist that none is more instructive and illuminating to the expert than the first, which deals with the historical aspect of cupolas. From a study of it, it becomes clear that the pioneers of the foundry industry, not being biassed by tradition and industry itself being of an experimental character, were true inventors. They covered by patent applications ideas which to-day are considered true novelties. Many of these may have been just "hopeful" patents, and the lack of precision machinery and metallurgical control precluded successful industrial development.

Because the author has achieved an international reputation as a theoretical foundry metallurgist, it must not be assumed that the book is crowded out with details of the theory of combustion. Rather the contrary is the case, and Chapters II to V are severely practical in character. They cover the construction, operation and charging of cupolas and the functioning of receivers.

Even in his chapter on combustion the author has eschewed any mathematical desiderata, except of the most elementary character. This statement also applies to Chapter VII, which, to our minds, does not bear a suitable caption in the word "Tuyères," as it deals with the appropriate height of cupolas and the weight of charges that should be carried. However, this is probably due to the slavish following of a system of giving each chapter a one-word significance.

Chapter VIII is designated "Specials" and covers all the recent devolopments in cupola construction, such as the Cameron, Ronceray, Poumay, Schurmann.

A chapter is devoted to "Blowers." Actually, of course, whilst blowers and fans are covered (six pages), the major portion of the space (10 pages) is devoted to blast measurement. When dealing with "Linings," we detect the result of the author's editorial experience in his non-committal phraseology. In dealing with plastic refractories, he says, "A typical mixture recommended for cupola purposes follows:—Ganister 40, crushed old firebrick 40, coke breeze 10 and fireclay 10 per cent." It would be interesting to learn if the author really does personally recommend this mixture.

The final chapter bears the caption "Briquets." Why, it is a little difficult to understand, as the subjects dealt with include melting losses, calculation of mixture compositions, use of canister containers, chemical binders, bonding by rusting, as well as the various phases of the preparation and utilisation of briquettes formed from turnings and borings. In justice to the editors, however, it should be pointed out that at the beginning of each chapter its subject-matter is detailed.

The book is excellently illustrated with 126 pictures and diagrams throughout its 220 pages, whilst the index is admirable. We cannot too strongly recommend this book for inclusion amongst one's personal technical library, as a complete practical treatise on cupola melting.

Silica Refractories.

By PROF. GEORGE KNOX.*

Although the iron and steel industry in this country was the pioneer in the use of silica as a refractory lining for steel-works practice, and although there are available enormous supplies of high-class raw material, the trade in refractories in this country instead of developing to meet the increasing demand has gradually declined. Considering the enormous development that has taken place in the use of refractories for coking coal, this decline is all the more remarkable.

If the raw material used by our Continental competitors had been superior in quality to that available in this country there might have been some reason for this industry declining locally, but their products are in no way superior to the best grades manufactured in this country.

It is often said that silica refractories are so uncertain in their behaviour that they cannot be relied upon at high temperatures, but the cases in which silica bricks have failed, when properly manufactured, are very rare. Our Continental competitors soon realised that if silica refractories were to be guaranteed to stand up to their work at high temperatures and under load, all doubtful ingredients had to be eliminated, proper grading and mixing of the materials had to be effected and care taken to calcine the material until the requisite change from quartz to tridimite or cristabolite had taken place. To accomplish this, properly-equipped laboratories had to be established at the works and a rigorous system of testing samples of the raw material, the ground products and the "burnt" bricks undertaken, with the result that refractories can be supplied to specification requirements without the least risk of failure.

Value of Tests.

These tests ensure that the silica content in the raw material is satisfactory and that the percentage of impurities is low and in the nature of a suitable flux for brick-burning. If the percentage of silica is excessively high, lime has to be added to form a bond, either in the form of quicklime or hydrated lime free from ash. In the grading tests after crushing, the ratio of fines to middlings and large particles is established where, by the elimination of excess in any size, the proper porosity value is obtained, and the grains packed in the best way to produce the necessary physical changes on calcining. The size of the larger particles and the ratio of these to the smaller sizes are varied according to the purpose for which the bricks are required.

In calcining, temperature must be controlled scientifically, exceptional care being taken when lighting up and during the initial stages to ensure that all moisture is slowly but completely eliminated. The temperature is gradually raised to the desired finishing temperature of about 1,550 deg. C.

Tests on Finished Products.

The finished products are then tested microscopically to ensure that the proper conversion of the quartz into its more staple forms (at high temperatures), tridymite and cristobalite, has taken place. They are also tested for fusibility, with and without load, for porosity, specific gravity and expansion under heat before despatch. This is a contrast to the "chance" methods pertaining in many refractory works in this country, and there can be no doubt it is the chief reason for ousting our home products from the home market. When it is realised that in South Wales there is an almost inexhaustible supply of high-grade quartzite deposits, at one time famous in the steel world, and that simply because manufacturers have failed to organise the industry to meet the changing conditions under which refractories have to be used, the trade has declined; the remedy is surely self-evident.

* Principal, Treforest School of Mines.

Cleaning of Castings.

HIGH-PRESSURE WATER-JET METHOD.

In an article in a recent issue of "Engineering Progress" MR. H. KALPERS states that the wet method for cleaning castings is not new in itself, and has for some time been receiving much attention in Germany. Because of the very high consumption of water entailed, however, the process did not until lately appear to be economical in operation. Opinions differed as to the pressure that should be used. Tests undertaken by Prof. U. Lohse in the foundry of Heinrich Lanz, of Mannheim, with the high-pressure hydraulic cleaner built by the Badische Maschinenfabrik, of Durlach, have now decisively demonstrated the operating and economical advantages inherent in the process. Although it is true that the expense for hydraulic pressure is considerable, the water-jet method effects a large reduction in the time required for cleaning. The casting to be cleaned is placed upon a truck, which is run into a completely-enclosed cabin. The casting in the cabin may be revolved from the outside to allow the water stream to play on all sides. The top of the cabin may be removed to allow the casting to be handled by a crane. The floor is in the form of a grate, and the loosened sand passes into a basin underneath. The spent water is cleaned and the sand recovered in settling tanks.

Necessary Labour.

The entire installation is operated by one man stationed outside the cleaning cabin, who directs the stream. His task is that of introducing the nozzle through an opening in the wall near the casting, and to watch the action of the stream through a window.

In working with the installation of the Badische Maschinenfabrik, the most favourable thickness of jet was found to be obtained with a nozzle diameter of between about 5 and 8 mm. (0.20 and 0.32 in.), irrespective of the pressure used. The working pressure is between 75 and 100 atmos. (1,050 and 1,400 lbs. per sq. in.). At the Lanz plant, a pressure of 75 atmos. (1,050 lbs. per sq. in.) is employed, the diameter of the nozzles being between 5 and 6.5 mm. (0.2 and 0.26 in.), depending upon the intended effect.

The action of the jet of water is comparable to that of a chisel used for breaking up the sand covering. In spite of the high pressure employed, water consumption is comparatively moderate, due to the small diameter of the nozzle.

Efficiency of the Method.

Elsewhere it has been tried to clean the piece at a distance and at low pressure by using a large nozzle opening and large quantities of water. The stream of water in that case has a rinsing rather than a scouring effect. With the high-pressure method, the sand adhering to the casting and the cores is so completely removed as to give the casting a perfectly smooth surface. Sand cores as well as oil cores immediately yield to the action of the high-pressure stream, leaving only the core nails to be removed by hand. Since these are also cleaned by the jet, they can immediately be used over again.

At the Lanz plant, the following times were obtained with the cleaning installation described, the time required for cleaning by hand being in each case added by way of comparison:—

Method.	Cylinders.	Crank cases.	Gear boxes.	Cylinders.
By hand ..	78 min.	115 min.	78 min.	188 min.
With water jet	50 ,,	42 ,,	35 ,,	122 ,,
Saving (per cent.)	36	63.5	55	35

It will be clear that the time required will partly depend upon the properties of the sand to be removed. Dense core sand is more difficult to remove than lean core sand, and the latter again is harder to clean off than ordinary moulding sand.

Comparative Researches of Heat-Treatment of Case-Hardened Steels.

DR. HELMUT LÜPFERT, of Stuttgart, in a recent issue of "Stahl und Eisen," gives an account of his recent researches on the heat treatment of case-hardened steels for the purpose of determining the effect of the various methods of treatment on different kinds of case-hardened steel, and particularly the dependence of grain size on the heating temperature, the duration of heating and the rate of cooling.

Three-dimensional diagrams were plotted for two case-hardened steels, one a carbon steel and the other a chrome-nickel steel, indicating the size of the grain at different temperatures and with different heating times and rates of cooling. These showed that the temperature and time must be adjusted to suit each other to obtain a given depth of case with as slight a coarsening of grain as possible. With all methods of heat treatment a deterioration of the case—shown by a reduction of the fracture load—took place. This detrimental action was proportionate to the temperature and the duration of heat treatment. If the metal is required to bear only moderate stresses, ordinary case-hardening may be used, in which case the rate of cooling after case-hardening exercises hardly any influence. But, whenever the material is to be subjected to the maximum stress, it should always undergo an intermediate heating.

The best core-toughness values were obtained with intermediate heating at 650 deg. C., with subsequent case-hardening. The properties of samples subjected to intermediate heating and air cooling were determined in relation to the duration of heating. The carbon steel showed a constant increase in total deflection proportionate to the length of the heating time. On the other hand, after a short period of heating, the chrome-nickel steel showed a high core-toughness, which was only slightly improved by prolonging the time of heating.

The bending test, with rods 19 mm. dia. and 250 mm. long, clearly showed the superiority of the alloy steel to the carbon steel. After quenching subsequent to case-hardening, the chrome-nickel steel gave a fracturing load of 2,100 kg. and a total deflection of 7 mm., the corresponding values for the carbon steel being 1,220 kg. and 4 mm. That this was due not merely to the greater strength and toughness which alloy steel possesses in itself, but also to its lesser tendency of the grain to become coarse, is obvious from the fact that in the case of the chrome-nickel steel the improvement in quality by the various methods of heat treatment was less than in the case of carbon steel.

According to the results of the tests, it is advantageous if materials which are to be subjected to an intermediate heating are subsequently cooled rapidly enough to produce a hardened structure. In that case the intermediate heating need only be of short duration, as this injures the material of the case only slightly and lessens the cost of the heat treatment. With carbon steel, water quenching will generally be necessary; oil cooling is sufficient only with material having a small cross-section. Alloy steel must be oil- or air-cooled, according to the alloy constituents and according to the cross-section. If hardening cracks or too great shrinkage is feared, it is desirable to employ the highest possible rate of cooling which the material will stand. The slower the cooling after heating, the longer will be the intermediate heating that must be used in order to impart a particular degree of toughness to the core.

With a carbon steel, and to a greater extent also with a chrome-nickel steel, tempering to 200 deg. C. after hardening is useful in removing stresses and also in improving the properties of the metal.

XUM

A Shortened Malleableising Process.

A new short-cycle annealing process for the production of malleable iron castings is announced by the Canadian General Electric Company, Limited. A number of advantages have resulted from the use of the new malleableising process, particularly a saving of many days, and this is expected to be a very helpful and important factor in the foundry's fight to keep pace with modern practices. Details of the new method were worked out in the Erie foundry of the General Electric Company. After ascertaining the proper temperatures and time involved to effect the required changes in the metal, it was found that, by the use of electric furnaces, a cycle of operations which was as near as possible to the ideal could be obtained.

Three electric annealing furnaces are used for this purpose at the Erie plant, each rated 325 kilowatts and using nickel-chromium ribbon resistor heating elements. The connections are arranged to allow a power input of 52, 170, or 325 kilowatts as desired. The capacity of the installation is 100 tons of castings per week. In operation, the hard castings, of commercial composition, are packed on the car bottoms or without iron plates or boxes, depending on the nature of the load. It was found that best results were obtained by stacking the charge directly on the floor of the car.

The charge is then placed in a furnace and heated to a sufficiently high temperature to effect solid solution of free cementite, whereupon the charge is transferred, without removing from the car, to another furnace for cooling. In this furnace the castings are brought to a temperature below 750 deg. C., which is held for approximately four hours, after which the temperature is suddenly lowered a few degrees and maintained at this lower temperature for another four hours, when this step is repeated. The castings are then transferred either to a cooling furnace or into the air, or they may be quenched immediately with increased strength and without brittleness. The average time for a six-ton anneal is between 28 and 30 hours.

Tests taken by the General Electric Company show that the tensile strength, yield point, and other characteristics are practically the same with the short-cycle anneal as with the older methods. It was found that the short-cycle malleable iron machines better than the long-cycle product, and shows no signs of framing or reversion. Very little skin is found and the castings clean somewhat easier than the old type of product. The castings may be galvanised without embrittlement and without previous or subsequent treatments. Warpage is also found to be reduced.

The advantages as found by the General Electric foundrymen are as follow:—(1) The elimination of boxes and packing material, reducing labour involved, eliminating hard cleaning if desired, and allowing much cleaner operation; (2) reduction of time resulting in less inventory, shorter deliveries, and a saving in space and furnace investment; (3) control of the anneal by varying the cycle, to meet variation in metal composition; and (4) lower cost.

H.M. STATIONERY OFFICE has reprinted Provisional Air Ministry Specification No. D.T.D. 50 for aluminium-silicon alloy sheets. The specific gravity of this aluminium-silicon alloy is 2.68 approximately. The chemical composition is standardised as follows:—Silicon, between 10 to 14; manganese, not more than 0.5; iron, not more than 0.75; and total impurities (other than manganese and iron), not more than 0.1 per cent. The mechanical tests specified are:—Maximum stress, between 13 and 15 tons per sq. in.; and bend test (both longitudinal and transverse), over a radius equal to 1T without showing signs of fracture.

Nickel-Chromium Steels in Trackwork.

Alloy castings for trackwork formed the subject of a Paper presented by J. Galibourg before the Association Technique de Fondérie during October. The author traced the early development of rail steels and drew attention to the important advance made when high manganese steel was introduced for this purpose. This form of steel, however, while offering high resistance to abrasive wear, suffers from numerous very serious defects, among which are a very low elastic limit and a marked tendency to brittleness, which render it incapable of resisting the shock effects to which rail crossings are subject in service.

In the course of research on steels which should be immune from these types of defect, work was instituted, in 1919, by the Milwaukee Tramway Company, on nickel-chromium steel rails, and these experiments were followed, in 1924, by very extensive work by the Aciéries de Gennevilliers. In spite of certain limitations due to the methods of steel manufacture which were then in operation, the results of the early experiments were of such a promising character that the subject of nickel-chromium steel for track work has since then been very actively pursued, and castings are now being produced characterised by high elastic limit and tensile strength and by a high degree of ductility and toughness.

The author emphasises that the use of nickel-chromium steel for trackwork is at present only in its early stages of development. A tentative specification has, however, been drawn up, which requires a composition of carbon 0.3—0.6, nickel 2.8—4, chromium 0.8—1.5 per cent. Steels of this type present no difficulties in fabrication, and can be welded without weakening of the surrounding portions of the steel, forming a joint of high fatigue resistance, while tests in service indicate that the steels are highly resistant to combined shock-abrasion wear, and that they are immune from the fissuring effects produced in manganese steel under parallel conditions.

A large number of points, crossings and rails have been put into service, both in America and France, and although their period of use is at present too short to enable a statement to be made as to length of life, the indications are that the final results will show conclusively the suitability of nickel-chromium steel for trackwork.

A second portion of the Paper deals with the testing of steel at elevated temperatures and with the properties of some nickel, nickel-chromium and nickel-chromium-molybdenum steel castings at temperatures up to 500 deg. C. (932 deg. Fah.), with special reference to their use for valves working at elevated temperatures.

The author describes a form of tensile-testing machine which permits of a very accurate and minute determination of the alterations occurring in steels when under test at high temperature; a number of diagrams are given illustrative of data obtainable with this form of apparatus. The Paper closes with some tabular details of the properties of nickel, nickel-chromium and nickel-chromium-molybdenum steels at 450 deg. and 500 deg. C. (842 deg. and 932 deg. Fah.).

A PAN-EUROPEAN foundry congress is scheduled to be held from June 22 to 28 at Liége. It will be associated with the sixth session of the International Mining, Metallurgical and Applied Geological Congress organised in connection with the 1930 exhibition.

Pattern Plate Cost Reduction.

LINOTYPE COMPANY'S EXPERIENCE.

Mr. George C. Scales, foundry manager of the Linotype Company, Limited, of Altrincham, Cheshire, has given us some interesting data on the application of "Titanite," the stone mixture for patternmaking, and the economies achieved in costs reduction, especially with regard to double-sided plates.

Mr. Scales has to deal with a large number of small castings for the various machines made by the Linotype Company, and as these castings are usually made by bench moulders it is not only a slow but a costly business. With the object of reducing costs Mr. Scales decided to make his pattern plates of "Titanite," and from the very commencement results were most successful in every way. Very much cheaper and quicker production was effected and the quality of the castings was very greatly improved. Time was not only saved in the foundry but by reason of the better castings obtained less time was needed in the finishing shop.

Compared with pattern plates that had previously been made of iron, the cost of the plates made with "Titanite" was very low, and a considerable saving was also made in the amount of time taken to make the plates of "Titanite." Only a few hours are needed in the latter instance, and the procedure is quite simple. There is no need for special patterns; ordinary loose patterns can be used with every confidence. Dealing with the question of the time taken to make plates with "Titanite," Mr. Scales said that a plate could be made in the afternoon, and castings made from the plate the following day. Only seven or eight hours are required for the plate to set, and a great advantage is that "Titanite" neither expands nor contracts. Asked what actual savings he had effected in making plates with "Titanite," Mr. Scales said that he had considered the cost against cast iron and other plates, and found that with "Titanite" he could make the plates at one-sixth of the cost of other materials. The "Titanite" plates are much lighter and easy to handle without causing any undue fatigue. Where boys are employed this is an important point.

Mr. Scales has made with "Titanite" double-sided plates of varying sizes up to 4 ft. 6 in. long by 2 ft. wide. These plates have lifts 4 in. deep and are only $\frac{3}{8}$ in. thick, but they are standing up to everyday usage and showing no signs of wear. There are about 1,500 "Titanite" plates at the Linotype works, and they are in continuous use, and, to quote Mr. Scales, "they look like lasting a lifetime."

For the making of these double-sided pattern plates, a hinged frame of aluminium was devised and the plates cast in them. When the castings have been made the plate is removed from the frame, which is ready for the next plate. After use the frameless plates are stored in racks, where they are readily available for future use. There is no real waste with "Titanite," as even obsolete plates can be used up to reinforce new plates.

"Titanite," it will be remembered, is made by the Constructional Engineering Company, Limited, Titan Works, Charles Henry Street, Birmingham.

DURING THE past three weeks the Rhodesia Railways have placed orders with British manufacturers for additional rolling-stock to the total value of £218,400. Twelve locomotives have been ordered from the North British Locomotive Company, Limited, eight enginemen's cabooses from Messrs. Hurst, Nelson & Company, Limited, 100 covered goods wagons from the Gloucester Railway Carriage & Wagon Company, Limited, six composite brake vans from Cravens Railway Carriage & Wagon Company, Limited, and fifty covered cattle wagons from the Birmingham Railway Carriage & Wagon Company, Limited.

STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM
S

American Foundrymen's Association Plans for 1930 Convention and Exhibition.

The selection of the Cleveland Public Auditorium for the 34th Annual Convention and the 23rd Exhibit of Foundry Equipment, Machines and Supplies of the American Foundrymen's Association, to be held during the week of May 12, 1930, was originally made primarily because of its exceptional facilities for housing this annual affair of the A.F.A. The Auditorium and Annex together afford accommodations for practically unlimited exhibit requirements in the way of space and power.

The management and exhibitors are planning to take full advantage of these facilities, and they are promising to make the 1930 exhibition the most outstanding foundry display ever held. The location of the Auditorium will do much toward making the meeting an ideal one, for Cleveland's hotels will accommodate the country's largest conventions, and most of these hotels are within easy walking distance of the Auditorium. This, and the fact that all convention sessions will be held in the meeting rooms of the Auditorium, will greatly conserve the time of both members and guests.

The Exhibition will be opened on May 12 at noon, in both the Auditorium and Annex. The closing hour on Tuesday, Thursday and Friday will be 5.0 p.m.

However, arrangements have been made to hold all exhibits open on Monday and Wednesday until 10.0 p.m. This is being done for the accommodation of those who desire to take advantage of both the morning and the afternoon convention sessions, and the plant visitations scheduled.

A welcome feature of the convention week is the Exhibitors' Dinner, which is arranged for Tuesday evening, May 13. Another annual affair is the A.F.A. Subscription Banquet, to be given on Thursday evening.

An added feature of the exhibit this year will be an educational and technical display, to be housed in the large, closed corridor connecting the Auditorium and the Annex. This exhibit will contain displays prepared by various committees of the A.F.A. and will include sand-testing apparatus, apprentice-contest material, exhibits of many engineering schools, castings, refractories and a metallurgical and physical testing laboratory.

The tentative programme for the convention includes sessions on metallurgy, engineering practice, management and practical shop operation. Because of the varied interests of the members and guests attending the meeting, the sessions this year will be organised as to limit the subjects covered at any one meeting. There will be a sufficient number of sessions, however, to cover all the important phases of foundry practice.

Under the management section will be sessions on general management problems, apprentice training and foundry costs. Metallurgical practice in the four major branches of the industry will be brought out in the regular sessions, organised on lines similar to those in force at past conventions.

Of considerable interest every year are the informal round-table luncheon discussion meetings. Three such round-table sessions are scheduled this year, covering malleable, steel and non-ferrous foundry subjects.

The shop operation courses will be broadened this year to include a course on the fundamentals of non-ferrous shop practice. In addition, both of the two courses held in 1929 on grey iron and steel will be continued. They are being organised essentially for the practical shop man and will be conducted by leaders thoroughly familiar with shop problems. Each course will consist of three or four sessions, beginning at 4.0 p.m. on the days scheduled.

All convention sessions will be held in the excellent meeting rooms available in the Auditorium. The tentative programme of sessions as at present organised is as follows:—

May 12.—10.0 a.m., Exhibition opening; 2.0 p.m., general opening meeting and business session; 4.0 p.m., shop operation courses.

May 13.—10.0 a.m., (A) foundry costs (non-ferrous and grey iron); (B) malleable founding; 12.15 p.m., malleable-foundry round-table; 2.0 p.m., (A) cast-iron founding; (B) non-ferrous founding; 4.0 p.m., shop operation courses.

May 14.—10.0 a.m., management; 12.15 p.m., non-ferrous round-table meetings; 2.0 p.m., sand control; 4.0 p.m., shop operation courses.

May 15.—10.0 a.m., (A) steel foundry practice; (B) apprentice training; 12.15 p.m., steel foundry round-table meeting; 2.0 p.m., non-ferrous foundry practice; grey-iron foundry practice; 4.0 p.m., shop operation courses.

May 16.—10.0 a.m., materials handling and general foundry practice; 5.0 p.m., Exhibition closing.

A number of authors new to A.F.A. programmes will present Papers on various foundry subjects at the convention. A tentative list of those who have signified their intention of submitting Papers, and the subjects to be covered by each, is as follows:—

"Electric Grey-iron Melting," B. C. Beach, Beach Foundry, Limited, Ottawa, Canada.

"Enamelling Properties of Cast Iron as Affected by Sands Used," C. J. Scullin, Tucker-Scullin Corporation, St. Louis.

"Use of Briquetted Borings in the Cupola," F. J. Walls, Wilson Foundry & Machine Company, Pontiac, Mich.

"Personnel Training," Dr. Harry Meyer, Frigidaire Corporation, Dayton, Ohio.

"Cleanliness and Neatness of the Foundry as a Business Asset," J. J. Carroll, G. & C. Foundry Company, Sandusky, Ohio.

"Application of Ingot Metal to Production of Brass and Bronze Castings," W. Romanoff, H. Kramer Company, Chicago.

"Effect of Pin-hole Porosity on Properties of Sand-cast Aluminium Alloys," E. M. Gingerich and H. J. Rowe, Aluminium Company of America, Pittsburgh.

"Heat-treating Cast Iron," F. J. Walls, Wilson Foundry & Machine Company, Pontiac, Mich.

"Carbon and Sulphur Equilibrium in Cupola," J. T. MacKenzie, American Cast Iron Pipe Company, Birmingham, Ala.

"Effect of Prolonged Heating at Various Temperatures on Cast Iron," R. S. MacPherran, Allis-Chalmers Manufacturing Company, Milwaukee.

"Steel Melting Problems," Geo. Batty, Steel Castings Development Bureau, Philadelphia.

"Factors Affecting Machinability of Malleable Iron," H. A. Schwartz, National Malleable & Steel Casting Company, Cleveland.

"Duplexing Process of Producing Malleable Iron," B. R. Mayne, Saginaw Products Company, Saginaw, Mich.

"Foundry Sand Control from Producers' Point of View," W. W. Kerlin, Enterprise Sand Company, Conneaut, Ohio.

"Gating and Risering of Castings," E. Ronceray, Bonvillain & Ronceray, Choisy-le-Roi, France.

"Wear Testing of Cast Iron," R. M. Allen, American Car & Foundry Company, New York.

"Technical Control of Brass-foundry Mixtures," H. C. Loudenbeck and A. M. Ondreyco, Westinghouse Air Brake Company, Wilmerding, Pa.

"Induction Furnaces for Ferrous and Non-ferrous Foundries," Manuel Tama, Berlin, Germany.

A Short-Paper Competition.

The meeting of the Junior Section of the Lancashire Branch of the I.B.F., held on December 21, was a very interesting one, the evening being devoted to the reading and discussion of short Papers written by members of the Section. For the best, a prize of one guinea was offered by Mr. W. Jolley. The conditions imposed were that the Paper must deal with a foundry subject and the time occupied in reading it must not exceed ten minutes. A committee, composed of Messrs. R. A. Miles (Section-President), T. Makemson, E. Flower, R. Stubbs and F. C. Demaine, will adjudicate.

There were six competitors. Several of them supplemented written matter and explanatory comment with diagrams and sketches. MR. J. PATTISON led off with an account of the testing of a cast-iron bar 14 in. long by 1 in. square, either cast-on or separated from the casting it represented. Cleaning by sand-blasting was the first operation mentioned. The bar might then be put on the grindstone or have the face machined. It was given a transverse test; measured for size, breadth and depth; possibly deflection figures were obtained; one half of it was sent into the chemical laboratory for analysis, the other half was Brinelled. Sometimes an impact or Izod test was carried out.

MR. G. H. COOPER chose for his theme, "A Day's Work with a 36-in. Cupola." He began with the removal of the bottom of the furnace after the previous day's work. The furnace was cooled, chipped down and got ready for the job. Tap hole and slag hole were made. In the feeding operation two men were engaged, one attending to the furnace, the other the charger. After the day's work had been done the wind was stopped, the tuyeres opened and cleaned, the legs knocked down and water put in to cool the bottom.

MR. A. FOX, with the help of sketches on the blackboard, gave his version of the making of a pitched chain pulley, a job, he remarked, comparatively easy to men acquainted with that class of work but very troublesome to men who had less experience. Great care had to be taken in the making and finishing of the mould. Three main points were: The ramming of the sand inside the rim or groove must not be too hard, nor too soft; the runner gate must be the correct size; the pattern must be drawn out carefully.

Plaster of Paris Work was dealt with by MR. G. PLATT. He observed that this method was introduced about 60 years ago, and had not been adopted extensively. It was only used for light work. Cheapness was the great recommendation.

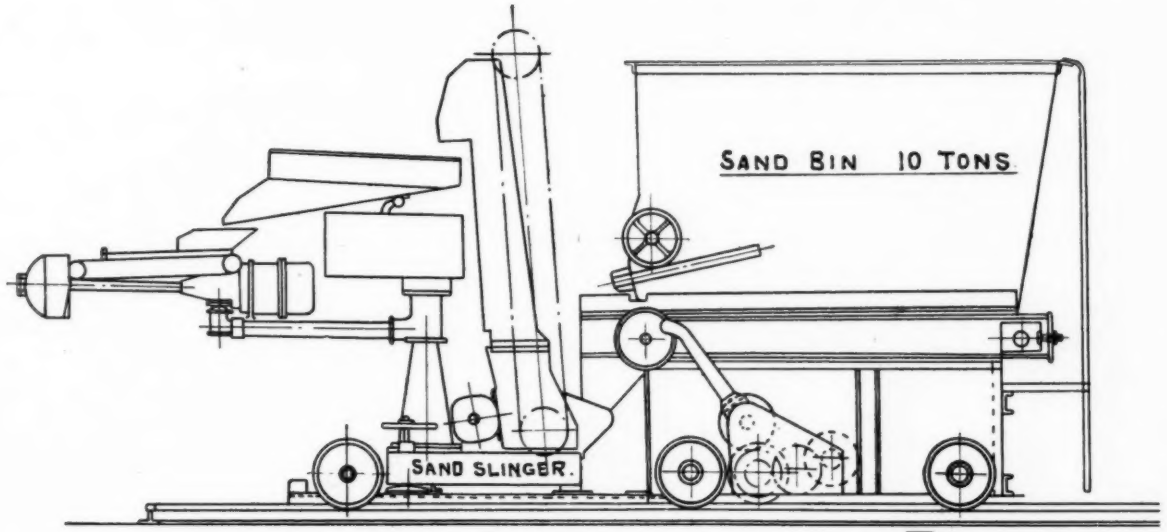
Moulding Sands were dealt with by MR. B. SIMPSON. The qualities or properties required, he said, were refractoriness, cohesiveness, porosity, plasticity, adhesiveness. An improvement could be made by the addition of other material, *e.g.*, coal dust; but this must be done with discretion. The best was obtained by selecting natural sands and blending them together and treating them according to the nature of the work to be done.

MR. E. SUTCLIFFE'S Paper was a plea for better co-operation between the foundryman and the drawing office. This would avoid many snags. Mr. Sutcliffe had prepared the ground by putting on the blackboard about 15 diagrams, and with their aid explained how jobs had gone wrong.

The BRANCH-PRESIDENT (Mr. R. A. Miles) concluded the proceedings by giving the members seasonable greetings and urging them to bring prospective new members to the next meeting.

THE CLEVELAND BRIDGE & ENGINEERING COMPANY, LIMITED, Darlington, have secured contracts for the construction of two bridges in Egypt.

A SANDSLINGER DEVELOPMENT



The Portable Sandslinger combined with motive feeder offers EXISTING USERS and NEW CUSTOMERS outstanding ADVANTAGES

1. Rapid mounting and dismounting.
2. Automatic and regulated sand feeding.
3. Standard lay-out increases crane utility.
4. Truck fitted with reversible motor.
5. Recognised elasticity and adaptability of the portable machine retained and expanded into the most utilitarian machine on the market.
6. Sand handling centralised.
7. Floor space economised.

Portable SANDSLINGER mounted on Motive Feeder

For further particulars apply—

FOUNDRY PLANT & MACHINERY LTD.

100, WELLINGTON STREET
GLASGOW

Trade Talk.

MESSRS. WILLIAM JACKS & COMPANY, iron, steel and metal merchants, have attained their jubilee this year. The firm was established in 1880.

SPECIAL COURSES of evening lectures on the manufacture of coal gas, refractory materials, and metallurgy have been arranged by the University of Leeds for delivery during the ensuing session.

THE NEW WORKS of the Northern Chromium Company, Limited, in Skinnerburn Road, Newcastle, were formally opened recently by Sir Andrew Duncan, chairman of the Central Electricity Board.

AN AGREEMENT has been completed by the Graesser-Monsanto Chemical Works, of Ruabon and London, for the acquisition of the Wear Tar Works, Sunderland, from Messrs. Brotherton & Company, Limited.

MR. E. RAMSAY, of Whitehaven, has been elected a director of Messrs. Robert Frazer & Sons, Limited, iron and steel merchants, of Newcastle-upon-Tyne. Mr. Ramsay has been associated with the firm for 26 years.

MESSRS. WILLIAM BAIN & COMPANY, LIMITED, Lochrin Iron Works, Coatbridge, have received an order for large double-storey transit sheds for the Harbour Commissioners in connection with the South African railways.

MR. ARTHUR J. TUSCANY, manager of the Grey Iron Institute (America), states that the standard cost finding system which the cost committee of the Institute has been preparing will soon be ready for distribution to members.

AN EXTRAORDINARY GENERAL MEETING of Associated Lead Manufacturers, Limited, passed a resolution increasing the capital to £2,900,000 by the creation of 275,000 additional 6 per cent. cumulative £1 preference shares and 125,000 £1 ordinary shares.

THE EMPLOYEES of the Rivet, Nut & Bolt Company, Glasgow, have subscribed £552 to local charities; Messrs. William Baird, Limited, Temple Iron Works, £47 to charities; and Messrs. Archibald Macmillan & Sons, Limited, £185 to infirmaries and other institutions.

MESSRS. HALL, RUSSELL & COMPANY, LIMITED, Aberdeen, have launched two steam trawlers, the "Fressia" and the "Gertrude W.," built to the order of Messrs Irvin & Johnson (South Africa), Limited, South Africa. The vessels are each 86 ft. in length, 18½ ft. broad and 10 ft. in depth, and have been specially designed for service in South African waters.

THREE SCOTTISH iron-producing firms who have cement works attached have combined to form what is known as Caledonian Portland Cement Company, Limited, with a view to developing the slag-cement industry. The firms concerned are Messrs. William Baird & Company, Limited; the Coltness Iron Company, Limited; and the Glasgow Iron & Steel Company, Limited.

MESSRS. SIEMENS BROTHERS & COMPANY, LIMITED, Woolwich, announce that arrangements have been made to transfer, as from January 1, their pyrometer and temperature measurement department to their associated company, Messrs. Elliott Brothers (London), Limited, of Lewisham, to whom all further inquiries and correspondence on temperature measurement matters should be addressed.

MESSRS. CHARLES CONNELL & COMPANY, LIMITED, have launched from their yard at Scotstoun the steel screw cargo steamer "Traprain Law," which has been constructed to the order of Messrs. Thos. Law & Company, Limited, Glasgow. The vessel is of 5,000 tons gross, and fitted with all the latest improvements for the rapid and efficient handling of cargo. Triple-expansion engines will be supplied by Messrs. David Rowan & Company, Limited, Glasgow.

NOTICES POSTED in Motherwell steelworks indicate that the New Year holiday will be longer than usual. The works closed on December 28, and will not reopen until January 13. The extended holiday is not welcomed by the staffs. It appears that considerable repairs and alterations are necessary, and the employers take the view that it is preferable to take a longer holiday at the present time, and so avoid suspensions and stoppages later in the year. There is no reason for pessimism in the trade outlook, as business is fairly good.

THE HON. R. D. KITSON, Col. Sir E. A. Johnson-Ferguson, Bt., the Hon. H. D. McLaren, Mr. B. Walmsley and Sir Holberry Monsforth, members of the board of Messrs. Bolckow, Vaughan & Company, Limited, were elected directors of Messrs. Dorman, Long & Company, Limited, at the meeting of the latter company recently. It was also announced at the meeting that two new directors, Mr. Charles Mitchell and Mr. Charles L. Dalziel, had been appointed directors, and that Dr. Arthur Cooper had expressed his wish to resign from the board. The shareholders appointed Mr. Ivor L. Johnson, who has been engaged in the collieries department of Messrs. Dorman, Long & Company, Limited, for some years, to a seat on the board in Dr. Cooper's place.

SHIPBUILDING RETURNS for the yards on the North-East Coast show that in 1929 the output on the Tyne was below that of 1928. Only six shipbuilding firms are now operating on the Tyne; the others have gone out of existence altogether, have been absorbed or have been idle. The total output of the river was 69 vessels, having a total tonnage of 284,161 tons, as compared with 70 vessels of 315,012 tons in 1928. Messrs. Swan, Hunter & Wigham Richardson, Limited, of Wallsend, launched 28 vessels having a tonnage of 99,797 tons. On the Wear, 58 vessels, of 243,924 tons, were launched; in 1928 the output was 50 vessels, of 207,676 tons. The Tees had a good year. In all 76 vessels, totalling 194,181 tons, were launched. Messrs. William Gray & Company, Limited, of West Hartlepool, built 91,136 tons.

Personal.

MR. WILLIAM MATHIESON, director and general manager of Messrs. Wilsons & Mathiesons, Limited, Scotch Foundry, Armley, Leeds, retired from that position on January 1, on the completion of exactly 66 years in the foundry industry. He is succeeded by his son, Mr. Wm. Mathieson, jun., who has become general manager of the three associated concerns—Wilsons & Mathiesons, Limited, Scotch Foundry (general light castings), Armley; Wilsons & Mathiesons, Limited, gas-stove department, Carlton Works, Armley, Leeds; and the London Scottish Foundry, Limited, Barking, Essex. Mr. Mathieson, sen., remains chairman of the company and consultant. He commenced his foundry career in 1864 at the Carron Ironworks, Falkirk, Stirlingshire, under his uncle, Mr. Malcolm Coburn. He received training and experience in various foundries and at the University of Glasgow. Eventually becoming proprietor of the Vulcan Foundry (subsequently known as Springfield Foundry), Falkirk, he developed so extensive a castings product for the gas-stove works of Charles Wilson & Sons, Leeds, that he subsequently transferred to Leeds, and established the firm of Mathieson, Wilson & Company, which later, by a complete combination of the two undertakings, became Wilsons & Mathiesons, Limited, as at present. The three undertakings now controlled by the company employ some 1,100 people.

Will.

THOMSON, HENRY, of Glasgow, retired metal broker £90,888

Obituary.

MR. HUGH M'GUINAN, whilst at work in the Waverley Iron Works, Coatbridge, came in contact with a live wire, and was electrocuted.

MR. THOMAS R. MARSH, formerly head of the Engineering and Contract Branches of the Office of the Crown Agents for the Colonies, has died in his 83rd year.

THE DEATH has occurred, at his home in Glasgow, of Mr. William Brown, C.B.E., chairman of Messrs. William Simons & Company, Limited, engineers and shipbuilders, Renfrew. Mr. Brown was in his eightieth year.

WE REGRET TO ANNOUNCE the recent death, at the age of 70, of Lieutenant-Colonel Montagu Cradock, C.B., C.M.G., associated as a director with the Metropolitan-Vickers Electrical Company, Limited, since its early days in 1902. Popularly known as "The Colonel," he endeared himself to everybody connected with the company, staff and workpeople by the unfailing interest he always showed in their welfare. Beginning his military career in the Durham Fusilier Militia in 1877, he served through the Afghan campaign, commanded the 2nd New Zealand Contingent, and later the 3rd Mounted Infantry Corps, and the Bushmen's Brigade in the South African War, and in August, 1914, raised the 2nd King Edward's Horse and commanded that unit until he retired in August, 1918. The interment took place in the family vault at Gilling, near Richmond, Yorks.

Company Meeting.

Steel Industries of Great Britain, Limited.—MR. W. BENTON JONES presided at the statutory meeting of Steel Industries of Great Britain, Limited, held in London recently. In the course of his address the chairman said:—This company was formed to purchase from Austin Friars Trust, Limited, the shares and securities of the United Steel Companies, Limited, and its subsidiary, United Strip and Bar Mills, Limited, the nominal value of which was £13,843,000. For the sake of brevity I shall refer to these companies as the Steel Companies. While it was in the minds of those who formed it that the properties belonging to the Steel Companies would form a nucleus around which it would be possible to build up a larger and more comprehensive unit of the steel trade of the country, the primary object was the acquisition of the Steel Companies, and that object has been attained in so far as your company at this moment is the holder of 97½ per cent. of the securities and shares of the Steel Companies. I am in a position to state that the assets of your company are not affected by the failure of Austin Friars Trust. All the securities and shares of the Steel Companies, against which shares of this company have been allotted, have been delivered to this company. Furthermore, transfers have been completed, and are in course of registration into the name of your company. But there is a matter in connection with Austin Friars Trust to which I desire to refer. It appears that documents purporting to be allotment letters of shares of Steel Industries of Great Britain, Limited, were issued by Austin Friars Trust, and I understand that, in all, these documents purport to represent 261,000 ordinary shares and 170,349 preference shares. The view of your directors and their adviser is that these documents, having been issued without the consent or knowledge of the directors, and without any allotment being made, are not binding on the company. As legal proceedings have been instituted by a holder of some of these allotment letters, and the matter is therefore *sub judice*, I cannot, of course, make any further comment. With regard to the future your directors believe that the scheme of reorganisation contemplated when the offer was made was a good one and that with such modifications as may now be necessary it should be completed. Towards this end they have taken the following steps: (1) They have prepared a scheme of reorganisation of the capital of the Steel Companies; (2) they have offered to purchase from holders of securities and shares of the Steel Companies who either did not accept Austin Friars' offer or who, having accepted, failed to deliver their shares, on the same terms as originally put forward by Austin Friars Trust. When the capital of the Steel Companies has been reorganised your company will possess an undertaking which, having regard to its mineral resources, its plant, its low capitalisation, and, if I may say so, its careful management, will constitute a sound industrial enterprise.

Reports and Dividends.

Sheepbridge Coal & Iron Company, Limited.—Interim distribution of 4d. per share.

Agricultural & General Engineers, Limited.—Receipts, £53,495 (including £33,902 from subsidiary companies); administrative expenses, etc., £52,458; brought in, £56,445, making £57,483. Eleven subsidiary companies made profits aggregating £235,596, while two made losses amounting to £19,838.

New Year's Honours List.

Amongst people prominent in the foundry industry whose names appear in the Prime Minister's Honours List we note the following:—

Sir Eustace Henry William Tennyson-D'Eyncourt, K.C.B., F.R.S., at one time Director of Naval Construction, Admiralty.

Mr. Archibald Page, Chief Engineer and Manager, Central Electricity Board, and a Past President of the Institute of Electrical Engineers.

Mr. Arthur Pugh, J.P., Secretary of the British Iron, Steel and Allied Trades Association.

"SERVICE BCM/GX FIRST."

Telephones:
SHEFFIELD 22311 (3 lines)
LONDON 1483 Central
GLASGOW South 1580
WORKSOP 205
AMBERGATE 7
STOCKSBRIDGE 27
GALSTON 49

MANUFACTURERS & PRODUCERS OF REFRACTORY MATERIALS OF EVERY DESCRIPTION
BRICKMAKERS · QUARRY AND MINEOWNERS CONTRACTORS & EXPORTERS.

GENERAL REFRACTORIES
LIMITED
Incorporating
THE GENERAL REFRACTORIES CO., LTD. THE MIDLAND REFRACTORIES CO., LTD.
THOMAS BROOKE & SONS LTD. WORKSOP BRICK CO. LTD. GUISELEY SILICA CO. LTD.

Telegrams:
"GENEFRAX"
Sheffield
London
Glasgow
Worksop
Monomarks:
BCM / GX
BCM/ Magnesia
BCM/ Coroma
BCM/ Pyrolyte
BCM/ Insulite

KELHAM ISLAND MILLS SHEFFIELD · LONGROUNDS BRICKWORKS WORKSOP · *Notts.* · BULLBRIDGE BRICKWORKS AMBERGATE · *Derbys* · GAYTON ROAD MILLS KINGS LYNN · THE BATTS MILLS WOLSINGHAM · *Dur.* · BRACKENHOOR FIRECLAY WORKS · STOCKSBRIDGE · LOUDOUN MILLS GALSTON · *Ayrshire*
AND AT MANSFIELD, WARSOP, EBBERSTON, CORBRIDGE, BRAMCOTE, LUFFENHAM, TOW LAW, MONTGREENAN &c.&c.

LONDON OFFICE
20 Budge Row E.C.4. (M^r A.C. Turner)

Head Office:
Wicker Arches, SHEFFIELD

GLASGOW OFFICE
82 Dale St. C.5 (M^r A.W. Montgomery)

ZENITH SAND

FROM OUR RECENTLY ACQUIRED QUARRIES AT KIDDERMINSTER

IS REMARKABLE FOR ITS REGULARITY

and its

ENTIRE FREEDOM FROM STONES, CLAY, PEBBLES AND DIRT.

EVERY WAGON-LOAD IS LIKE THOSE BEFORE AND THOSE AFTER IT

The red sands of Worcestershire are very valuable to the Iron-founder when clean and reliable, but they are peculiarly liable to variation and contamination. Zenith Sand is entirely free from irregularities.

Free sample bags on application.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The opening of the New Year's markets for pig-iron has not been distinguished by any striking development of the previous position, business generally being held up until the completion of the holiday season. Meanwhile, some accumulation of stocks has been inevitable on Tees-side, and ironmasters will therefore be faced with the disposal of their surplus after the holidays. No serious apprehensions on this score are entertained. Indeed, accumulation will to some extent be limited by the fact that two blast furnaces on Cleveland foundry iron are temporarily out of action. On the whole, therefore, a hopeful view is entertained regarding the business outlook. It is believed that some fairly substantial orders will be released early in the New Year, and possibly fears of a rise in coal prices as a consequence of the Coal Mines Bill may impel buyers to place forward contracts before fuel prices drive up the cost of pig-iron still further. In the export trade, foreign buyers still decline to pay the quoted prices, and the volume of shipments has fallen away very sharply. Even home consumers have inclined to delay purchases, but a brisk resumption of business is looked for early in the New Year, when consumers will no longer be preoccupied with thoughts of holidays and stocktaking. Prices, however, are firm and unchanged, the standard No. 3 Cleveland G.M.B. quality being at 72s. 6d., No. 1 foundry iron 75s., No. 4 foundry 71s. 6d., and No. 4 forge 71s. per ton.

Suspension of deliveries will throw on to the makers' hands a certain amount of East Coast hematite, but they have some big contracts to execute over the next two or three months and continue to quote a premium of 1s. to 2s. per ton for forward delivery. Prompt lots of mixed numbers are now on offer at 78s. 6d. per ton, and that figure has been shaded for shipment. On the North-West coast Bessemer mixed numbers are quoted at 77s. 6d. to 78s. per ton at works.

LANCASHIRE.—The outlook in the local markets for foundry pig during the ensuing few months is regarded as fairly satisfactory, for with the quietly steady flow of orders recently placed for forward delivery, in which Lancashire consumers have played their part, there is reasonable certainty of active conditions during the next three months. Values are very firm all round, with Derbyshire and Staffordshire brands at 77s. per ton for delivery to local users, with Scottish iron round about 95s. per ton delivered equal to Manchester.

THE MIDLANDS.—The demand for pig-iron has not eased during the holidays, as the ironfounders had no stocks and consequently have not withheld instructions to the furnaces for supplies. In the circumstances it would not be surprising to find shortly that the furnaces were asking premiums over the present "zone" rates, which are 75s. for No. 3 Northants and 78s. 6d. for No. 3 Derbyshire and No. 3 Staffordshire, delivered local stations.

SCOTLAND.—Business passing this week has been very meagre, but traders are hoping that after the holidays it will show some expansion. Meanwhile, most of the buyers seem to have good supplies of pig-iron, and are showing no anxiety to commit themselves. The basis price of 78s. for No. 3 Scotch foundry iron at the furnaces remains unchanged, but already some makers are talking of a further advance.

Steel.

In common with other sections of the markets, business in semi-products has been quiet and uneventful. It is too early yet to judge whether the minimum prices fixed by the Continental Steel Cartel will be adhered to, but some doubts as to the possibility of this have been expressed in this country. The position as regards home-produced semi-finished steel shows no alteration. As regards the outlook in the New Year, conditions are regarded as fairly favourable. It is believed that the consuming trades will be operating on a more active scale and that the demand for iron and steel will be correspondingly increased. In the tinplate market prices are firmly held, with coke-plate quotations ruling from 18s. 6d. to 19s. basis, f.o.b. Welsh ports.

Scrap.

With the resumption of work at the foundries this week, business in scrap metals has been on a slightly increased scale, but with little change in the general position. Prices, however, continue fairly steady, and on Tees-side 62s. 6d. per ton remains an unchanged quotation for ordinary heavy cast iron, whilst machinery quality, the supply of which is somewhat limited, stands at 66s. 6d. per ton. In Scotland the cast-iron scrap position has not improved, and there are practically no outlets for machinery metal even at around 68s. 6d. to 70s. Ordinary heavy cast-iron scrap suitable for cupolas is in a similar position at 63s. 6d. to 65s., and steelworks cast iron is nominally at 61s. 3d.

Metals.

Copper.—The New Year markets for copper opened with a steady tendency in values, conditions considered likely to prevail owing to favourable views of the statistical position. The November statements disclose:—Total stocks in Metal Exchange warehouses, 6,186 tons. Imports into the United Kingdom during the month:—From the British Empire, 614 tons; United States, 7,353 tons; Chile, 2,935 tons; Africa, nil; miscellaneous, 568 tons. Exports during the month:—To the Dominions, 62 tons; Europe, 1,161 tons; other countries, 1,025 tons. Receipts into warehouse during the month, 1,436 tons. Deliveries from warehouse during the month, 2,164 tons.

As usual, the Metal Exchange was closed on New Year's Day. Daily quotations for copper since our last report have been:—

Cash.—Tuesday, £67 16s. 3d. to £67 18s. 9d.; Friday, £67 10s. to £67 12s. 6d.; Monday, £67 3s. 9d. to £67 6s. 3d.; Tuesday, £67 17s. 6d. to £68 2s. 6d.

Three Months.—Tuesday, £67 3s. 9d. to £67 5s.; Friday, £67 5s. to £67 7s. 6d.; Monday, £66 16s. 3d. to £66 17s. 6d.; Tuesday, £67 5s. to £67 6s. 3d.

Tin.—The recent advance in values of standard tin is regarded as attributable to some extent to an improvement in sentiment following on the announcement of a proposed fusion of five important interests engaged in the tin mining and smelting industry. The companies concerned are the London Tin Syndicate, Limited, the Tin Selection Trust, Limited, the London Malayan Tin Trust, Limited, the Anglo-Bauchi Tin Dredging, Limited, and the Mongu (Nigeria) Tin Mines, Limited. Prices have since registered a fall.

Official closing prices:—

Cash.—Tuesday, £180 to £180 2s. 6d.; Friday, £177 5s. to £177 7s. 6d.; Monday, £175 2s. 6d. to £175 5s.; Tuesday, £178 2s. 6d. to £178 5s.

Three Months.—Tuesday, £183 2s. 6d. to £183 7s. 6d.; Friday, £180 12s. 6d. to £180 15s.; Monday, £178 12s. 6d. to £178 15s.; Tuesday, £181 12s. 6d. to £181 15s.

Spelter.—Prices of spelter have fallen, due, probably, to the fact that good supplies of the metal are arriving and that the demand from the galvanising trade remains poor. The November statistics show:

Total stocks in Metal Exchange warehouses, 2,401 tons. Imports into the United Kingdom during the month:—From Canada, 960 tons; other Dominions, 313 tons; U.S.A., 1,968 tons; Belgium, 3,664 tons; Poland, 50 tons; Scandinavia, 555 tons; Germany, 1,376 tons; all other European countries, 254 tons; miscellaneous, 37 tons. Exports during the month: To the Dominions, 201 tons; Europe, 250 tons; other countries, 51 tons. Receipts into warehouse during the month, 762 tons. Deliveries from warehouse during the month, 1,896 tons.

Daily quotations are:—

Ordinary.—Tuesday, £20 1s. 3d.; Friday, £20; Monday, £19 16s. 3d.; Tuesday, £19 12s. 6d.

Lead.—A rather more active inquiry has developed of late in the market for foreign pig, with values steady on the whole. The statistical position continues sound, and at the moment few violent fluctuations in quotations may be anticipated in the near future.

The week's prices have been:—

Soft Foreign (Prompt).—Tuesday, £21 10s.; Friday, £21 10s.; Monday, £21 10s.; Tuesday, £21 10s.

Students' Corner.

Q.—What factor decides whether a casting should be fed by rod from a basin, or by feeding head?

A.—Chiefly design, method of moulding and the position of the mould when it is poured.

Q.—What is implied by dry feeding?

A.—Dry feeding is when the feeding rod is pushed up and down into the casting when the part that is being fed has reached the stiff pasty stage. There is no liquid metal to follow the rod. Hence if the movement of the rod is persisted in, or continued, a dry hole is left in the casting made by the rod instead of a sound solid place.

Q.—Why are feeding rods heated before using?

A.—For two reasons. First, in order that the molten metal will not easily solidify around the rod when it first enters the molten metal, thus having a heavy dirty rod to start with; and, secondly, which is the more important, that rust and moisture are removed from the rods. Hence the chilling effect of the molten metal is removed, and the rod is free from any explosive matter.

CAST IRON FLANGED PIPES
2 in.–12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 52 & 53. MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

BEDWAS NAVIGATION FOUNDRY COKE

(Produced from the world-famous Bedwas Coking Coal.)

The British Benzol & Coal Distillation, Ltd., beg to announce that their new Woodall-Duckham Plant at Bedwas is now in operation.

Enquiries are invited from all those interested in high-grade Foundry and Furnace Coke.

S. INSTONE & CO., LTD.,
Sole World Sales Agents,
Baltic House, CARDIFF.

Agents for the Midlands :
J. C. ABBOTT & CO., LTD.,
Lloyds Bank Chambers,
New Street, BIRMINGHAM.

WARNER'S CYLINDER PIG IRON

THE WORLD'S BEST

BRAND "WARNER C.P.R."

As supplied to the leading.... RAILWAY COMPANIES, LOCOMOTIVE, DIESEL and OIL ENGINE BUILDERS.
Also unequalled for AUTOMOBILE CYLINDER BLOCKS. COMPRESSORS, ENGINEERS' TOUGH CASTINGS and CHILLED ROLLS.

WARNER & CO. LTD.
CARGO FLEET, MIDDLESBROUGH ON TEES.

TELEGRAMS: REFINERY MIDDLESBROUGH.

ALSO MAKERS OF HIGH CLASS REFINED PIG IRON IN SMALL PIGS, FOR ALL KINDS OF MALLEABLE CASTINGS

TELEPHONE: MIDDLESBROUGH 4265.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	67	17	6
Three months	67	5	0
Electrolytic	83	0	0
Tough	74	0	0
Best selected	75	10	0
Sheets	110	0	0
India	90	10	0
Wire bars	83	15	0
Do. Jan.	83	15	0
Do. Feb.	83	15	0
Ingot bars	83	15	0
H.C. wire rods	85	17	6
Off. av. cash, December	68	7	3⅜
Do., 3 mths., December	67	15	10⅝
Do., Sttlmnt., December	68	7	3
Do., Electro, December	83	3	6¾
Do., B.S., December	75	16	4⅝
Do., wire bars, December	83	15	9
Aver. spot price, copper, Dec.	68	7	3⅜
Solid drawn tubes			15d.
Brazed tubes			15d.
Wire			11½d.

BRASS.

Solid drawn tubes	12¾d.
Brazed tubes	14¼d.
Rods, drawn	12½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	11½d.
Wire	10⅞d.
Rolled metal	10⅝d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	178	2	6
Three months	181	12	6
English	179	0	0
Bars	181	0	0
Straits	180	7	6
Australian	180	2	6
Eastern	183	5	0
Banca	189	2	6
Off. av. cash, December	179	10	2¼
Do., 3 mths, December	182	14	0
Do., Sttlmt., December	179	9	7½
Aver. spot, December	179	10	2¼

SPELTER.

	£	s.	d.
Ordinary	19	12	6
Remelted	18	10	0
Hard	16	10	0
Electro 99.9	21	15	0
English	20	0	0
India	18	5	0
Zinc dust (Nom.)	31	10	0
Zinc ashes	6	10	0
Off. aver., December	20	7	5½
Aver., spot, December	20	1	3¼

LEAD.

	£	s.	d.
Soft foreign ppt.	21	10	0
English	23	5	0
Off. average, December	21	9	6¾
Average spot, December	21	9	5¾

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	30	0	0
Do. V.M. ex-whf.	27	15	0
Rods	34	0	0
Boiler plates	26	10	0
Battery plates	27	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	48	15	0
Chinese	31	5	0
Crude	19	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	23	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
	£19 0 0
Ferro-vanadium—	
35/50%	12/10 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/- lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%, c. fr.	3/1½ lb.
Tungsten metal powder—	
98/99%	3/4½ lb.
Ferro-chrome—	
2/4% car.	£30 10 0
4/6% car.	£23 5 0
6/8% car.	£22 15 0
8/10% car.	£22 7 6
Ferro-chrome—	
Max. 2% car.	£33 12 6
Max. 1% car.	£39 0 0
Max. 0.70% car.	£41 5 0
70%, carbonless	11d. lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£12 10 0
76/80% packed	£13 10 0
76/80%, export	£13 0 0
Metallic manganese—	
94/96%, carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				3	7	6
Bundled steel and shrngs.	3	2	6	3	6	0
Mixed iron and steel	3	3	0	3	4	0
Heavy cast iron	2	19	0	3	0	0
Good machinery for foundries	3	2	6	3	5	0
Cleveland—						
Heavy steel				3	3	6
Steel turnings				2	16	6
Cast-iron borings				2	13	0
Heavy forge				3	15	0
W.I. piling scrap				3	10	0
Cast-iron scrap	3	2	6	3	6	6
Midlands—						
Ord. cast-iron scrap				3	5	0
Heavy wrought				3	17	6
Steel turnings	2	2	6	2	5	0
Scotland—						
Heavy steel				3	9	0
Cast-iron borings				2	12	6
Wrought-iron piling				3	19	0
Heavy machinery				3	9	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	61	0	0
Brass	43	0	0
Lead (less usual draft)	19	0	0
Tea lead	15	0	0
Zinc	13	10	0
New aluminium cuttings	65	0	0
Braziery copper	57	0	0
Gunmetal	54	0	0
Hollow pewter	132	0	0
Shaped black pewter	98	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	75/-
Foundry No. 3	72/6
Foundry No. 4	71/6
Forge No. 4	71/-
Hematite No. 1	79/-
Hematite M/Nos.	78/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
„ d/d Birm.	93/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	74/6
„ No. 3 fdry.*	78/6
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	71/-
„ fdry. No. 3*	75/-
Derbyshire forge*	74/6
„ fdry. No. 3*	78/6
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	80/6
„ No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	69/6
„ fdry. No. 3	73/6
Lincs. forge.	72/-
„ fdry No. 3	76/-
E.C. hematite	88/6
W.C. hematite	91/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	77/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	95/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/-
Monkland, No. 3	95/-
Shotts, No. 3	95/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom.				10	15	0
Nut and bolt iron	9	2	6	9	7	6
Hoops				11	0	0
Marked bars (Staffs) f.o.t.				12	10	0
Gas strip				11	0	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0
Steel—						
Ship plates	8	15	0	8	17	6
Boiler plts.	9	15	0	10	10	0
Chequer plts.				10	12	6
Angles				8	7	6
Tees				9	7	6
Joists				8	10	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ¾ in. (Untested)				8	2	6

and upwards

	£	s.	d.	£	s.	d.
Flats—8 in. wide and over	8	12	6			
„ under 8 in. and over 5 in.	8	17	6			
Rails, heavy				8	10	0
Fishplates				12	10	0
Hoops (Staffs)				9	15	0
Black sheets, 24 g.				9	17	6
Galv.cor.shts., 24g.	12	10	0	12	12	6
Galv. fencing wire, 8g. plain				12	0	0
Billets, soft	6	2	6	6	12	6
Billets, hard	7	10	0	8	0	0
Sheet bars	5	17	6	6	5	0
Tin bars	5	17	6	6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/4
Sheet to 10 w.g.	1/5
Wire	1/6
Rods	1/5
Tubes	1/9½
Castings	1/4

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y, at mill	43.00
Bessemer billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	35.00
Wire rods	40.00
	Cents
Iron bars, Phila.	2.12
Steel bars	1.90
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.85
Skelp, sheared steel	1.85
Steel hoops	2.20
Sheets, black, No. 24	2.75
Sheets, galv., No. 24	3.40
Sheets, blue an'l'd, No. 13	2.13
Wire nails	2.40
Plain wire	2.40
Barbed wire, galv.	3.05
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	35/- to 36/-
„ furnace	30/- to 32/6
Durham and Northumberland—	
„ foundry	19/-
„ furnace	20/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/9
„	28×20 „	38/-
„	20×10 „	27/6
„	18¾×14 „	19/6
C.W.	20×14 „	16/-
„	28×20 „	34/-
„	20×10 „	22/7½
„	18¾×14 „	16/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	65% ..	.. 47½%
Water	61¼% ..	.. 42½%
Steam	57½% ..	.. 37½%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.	
Dec.	24	..	67	16	3	dec. 1/3
,,	27	..	67	10	0	,, 6/3
,,	30	..	67	3	9	,, 6/3
,,	31	..	67	17	6	inc. 13/9
Jan.	1	..		——		

Electrolytic Copper.

			£	s.	d.		
Dec.	24	..	82	10	0	No	change
,,	27	..	82	10	0	,,	,,
,,	30	..	82	10	0	,,	,,
,,	31	..	83	0	0	inc.	10/–
Jan.	1	..		——			

Standard Tin (cash).

			£	s.	d.		
Dec.	24	..	180	0	0	inc.	35/–
,,	27	..	177	5	0	dec.	55/–
,,	30	..	175	2	6	,,	42/6
,,	31	..	178	2	6	inc.	60/–
Jan.	1	..		——			

Tin (English ingots).

			£	s.	d.		
Dec.	24	..	180	10	0	dec.	10/–
,,	27	..	177	15	0	,,	55/–
,,	30	..	176	0	0	,,	35/–
,,	31	..	179	0	0	inc.	60/–
Jan.	1	..		——			

Zinc Sheets (English).

			£	s.	d.		
Dec.	24	..	30	0	0	No	change
,,	27	..	30	0	0	,,	,,
,,	30	..	30	0	0	,,	,,
,,	31	..	30	0	0	,,	,,
Jan.	1	..		——			

Spelter (ordinary).

			£	s.	d.		
Dec.	24	..	20	1	3	inc.	1/3
,,	27	..	20	0	0	dec.	1/3
,,	30	..	19	16	3	,,	3/9
,,	31	..	19	12	6	,,	3/9
Jan.	1	..		——			

Lead (English).

			£	s.	d.		
Dec.	24	..	23	5	0	No	change
,,	27	..	23	5	0	,,	,,
,,	30	..	23	5	0	,,	,,
,,	31	..	23	5	0	,,	,,
Jan.	1	..		——			

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1887	37 5	35 10	34 4	34 4	34 1	34 10	34 4	34 5	33 9	31 10	31 8	33 6	34 2
1888	32 2	31 1	31 5	31 9	30 11	31 5	32 4	33 5	34 8	34 2	33 11	33 10	32 7
1889	33 8	35 0	37 5	38 9	38 6	37 10	40 1	43 4	44 1	51 5	64 7	61 1	43 10
1890	60 3	53 1	51 0	47 4	42 2	41 5	43 2	45 7	47 9	47 10	47 4	43 1	47 6
1891	42 1	41 10	39 9	38 7	40 9	41 0	40 8	39 8	40 4	39 11	38 8	38 1	40 1
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 3	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 2
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 0	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 0	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	43 11	46 7	46 0	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	68 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

CUMBRIA

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.

(A remittance should accompany instructions.)

SITUATION VACANT.

FURNACEMAN wanted immediately, one having had experience with pit fires and the cupola. Only those with experience on both types of furnace need apply. State fully where experience gained, age, and wages required. Constant work for the right man.—Apply, H. H. MARTYN & COMPANY, LIMITED, Sunningend Works, Cheltenham.

AGENCY.

A FIRM of Bronze and Iron Founders, specialising in Architectural and Decorative Castings, desires to appoint Agent on commission basis; one with good connection amongst users of fine-faced castings up to 30 cwts.—Box 400, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE.

SHEFFIELD.

145,000 Sq. Ft. of SHOPPING,

Compact and Convenient.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

BARGAIN IN TRAFFORD PARK.—Engineering Works and Foundry; private sidings, warehouse, packing rooms; fine offices; central heating; all on one storey and easily adaptable; cost £20,000 in 1921—price £2,000, including two 4-ft. Modern Cupolas and Steel Chimney.—F. S. AIREY, ENTWISTLE & COMPANY, 10, Norfolk Street, Manchester.

FINANCIAL.

OLD-ESTABLISHED Engineering Company, South Yorkshire, with wide connection, private limited company, require additional capital, for development.—Full particulars on application to Box 404, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

'Phone **98** Staines.

20-kw. Crude Oil GENERATING SET, Semi-Diesel, Robey-E.C.C., 220/240 volts D.C.
25-n.h.p. Loco-type BOILER by Ruston, 115 lbs. w.p.
12-b.h.p. Hornsby CRUDE OIL ENGINE.

HARRY H. GARDAM & COMPANY, LIMITED, STAINES.

NEW "DEUTSCHE NILES" Vertical Boring and Turning Mill, with side head, capacity without side head 47 in. dia., with side head 41⅜ in.

NEW "BLANCHARD" Type Vertical Surface Grinder, with magnetic chuck 19½ in. dia.

34 in. swing DEFRIES Vertical Boring and Turning Mill, with 30-in. chuck.

No. 60 HEALD Internal Grinding Machine, with planetary head.

Four excellent HORIZONTAL DOUBLE-GEARED STEAM WINCHES (Clarke Chapman and Roger), each having cyls. 7 in. dia. x 10 in. stroke.

About 40 excellent HORIZONTAL DOUBLE-GEARED STEAM WINCHES (Clarke Chapman, Ruston Proctor, etc.), cyls. 4½ in. dia. x 6 in. stroke.

One New 10-n.h.p. PORTABLE STEAM ENGINE AND BOILER, completed 1929.

FOUNDRY LADLES, various types and sizes.

100,000 ft. of 4-in. Wrought Iron Screwed and Socketed Piping, in lengths of about 18/21 ft., to British Standard Specification and tested to 270 lbs. hydraulic pressure.

(ASK FOR "ALBION" MACHINERY CATALOGUE.)

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

PATTERNS IN WOOD AND METAL for all branches of Engineering. Moulding methods carefully considered.—FURMSTON & LAWLOR, Letchworth.

MISCELLANEOUS—*Continued.*

NON-FERROUS CASTINGS. — Inquiries solicited from the Trade. Prompt attention; first-class products; reasonable prices.—PRECISION CASTINGS, LIMITED, Lincoln Street, Wolverhampton.

RAMMING GANISTER.—Lowest prices from E. STAFFORD, Lowick, Kettering.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

GANISTER, best quality for cupolas, also for Steel Works.—ASTBURY SILICA COMPANY, "The Brooms," Park Lane, Congleton.

PURIC CUPOLA FLUX cleanses and desulphurises all cupola mixtures. No appreciable increase in cost of mixture. Over 600 foundries have testified to the advantage of using Puric. Send for a trial 1 cwt. at 35s.—Write, BEECROFT & PARTNERS, LIMITED, The Foundry Chemists, Retort Works, Mappin Street, Sheffield. Analysis and testing carried out at low rates.

FLUORSPAR. — The Ideal Flux for all Foundry and Furnace work; supplied in crude lump, washed gravel or finely ground. Samples and prices from

A. BECK,
MINEOWNER, MATLOCK.

'Phone: 287 SLOUGH

TABOR

"SHOCKLESS" MACHINES

8" Plain jolter, 51"×42" table	£90
13" Plain jolter, 76"×52" table	£140
24"×48" Portable turnover jolter	£130
18"×36" Portable turnover jolter	£90
30"×40" Turnover jolter, 20" draw	£140
50"×60" Turnover jolter, 30" draw	£440
"ADAPTABLE" machine, standard type	£15

LARGEST STOCK OF FOUNDRY PLANT IN ENGLAND. PLEASE SEND FOR LISTS.

BUY FROM ME AND SAVE MONEY

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

Regular repeat orders from Ironfounders all over the United Kingdom testify to the merits of—

ROSS

Quick Drying Bituminous

BLACK VARNISH

Sole Manufacturers:

SCOTTISH TAR DISTILLERS, LTD.

Lime Wharf Chemical Works, FALKIRK.

Telegrams: "Ross, Falkirk." *Telephone:* No. 415-416 Falkirk.

ABSOLUTELY DRY IN 15 MINUTES

Does not crack or chip off.
Used by the leading Ironfounders, Constructional Engineering Firms and Shipbuilders.
Gives a fine Glossy Finish.
Suitable for painting all classes of Iron and Steelwork exposed to the weather or noxious fumes and gases.